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AND

JOURNAL

OF THE

Mineralogical Society.

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THE MINERALOGICAL SOCIETY

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EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, June 21st, 1898.

Prof. A. H. Church, M.A., F.R.S., Vice-President, in the Chair.

The death of Professor Sandberger, Honorary Member, was announced.

A letter from Mr. Thoms, relative to the proposed publication of Prof. Heddle's *Mineralogy of Scotland*, was read.

GENERAL MEETING.

Held in the Apartments of the Geological Society, June 21st, 1898.

Prof. A. H. Church, M.A., F.R.S., Vice-President, in the Chair.

Thirteen Members and two Visitors were present.

The following papers were read:—

1. On some crystal forms of Lead: a study in crystal measurement: by Professor Miers (page 113).

2. On the chemical composition of Chalcophyllite: by Mr. E. G. J. Hartley (page 120).

3. On a possibly dimorphous form of an oxy-chloride of lead: by Mr. Herbert Smith (page 108).

Mr. Tutton exhibited an improved form of interference-dilatometer, and demonstrated the mode of use.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, October 4th, 1898.

Professor N. S. Maskelyne, M.A., F.R.S., President, in the Chair.

A proposal for an exchange of publications with the Imperial University of Moscow was accepted.

Resolved to nominate for the new Council as follows:—

President: Prof. Church (in succession to Prof. Maskelyne).

Vice-President: Prof. Liveing (in succession to Prof. Church). Messrs. Cole, Gurney, Platnauer, Teall, Tutton and Watts (in succession to Messrs. Church, J. Geikie, Hutchinson, Kitto, Liveing and Rutley), as Members of Council.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, November 15th, 1898.

Prof. N. S. Maskelyne, M.A., F.R.S., President, in the Chair.

MM. Fouqué and Lévy were elected Corresponding Members of the Society.

Mr. J. P. de Castro, B.A., and Mr. H. C. Dickson were elected Ordinary Members of the Society.

The Draft Annual Report prepared by the Secretary was emended and approved.

ANNIVERSARY MEETING.

Held in the Apartments of the Geological Society, November 15th, 1898.

Prof. N. S. Maskelyne, M.A., F.R.S., President, in the Chair.

Eighteen Members were present.

The following Report of Council for the Session 1897-8 was read:—

REPORT.

The Balance Sheet for the year ending December 31st, 1897, which was issued with Number 54 of the Journal, showed that the state of the Finances of the Society was all that could be wished, the Assets (exclusive of the Stock of the Journal and the Library) amounting to £568 19s. 9d., and the Liabilities to £47 16s. 10d. The number of actual Members who had compounded before December 31st, 1897, for the payment of their Annual Subscription was 44.

During the Session 1897-8 two Members have been removed by death, namely, Professor Heddle, Past-President, and Professor Sandberger, Corresponding Member; one Member has resigned; five non-effective Members have been removed for non payment of their Subscriptions: on the other hand, two Corresponding Members and three Ordinary Members have been elected to the Society.

The total number of Members is now 131: of these 110 are Ordinary Members and 21 are Corresponding Members.

Four Meetings have been held during the year, all in London, and (by kind permission) in the Apartments of the Geological

Society, Burlington House. The attendances at these Meetings have been 15, 18, 11 and 15, respectively.

Two Numbers of the Journal, published in December 1897 and June 1898, respectively, have been issued since the last Anniversary Meeting. To Number 53 Professor Miers contributed detailed information relative to British Pseudomorphs, information which it is very useful to place on record. Messrs. Prior and Spencer gave an elaborate report of their investigations relative to the species Andorite, Sundtite and Webnerite, and established their identity. Dr. Hussak, who is adding so much to our knowledge of the Mineralogy of Brazil, described, in conjunction with Mr. Prior, a new species, an antimonate of iron, Tripuhyite. Mr. Derby, also working in Brazil, announced the common occurrence of Monazite and Xenotime in the far-distant European rocks. Mr. Mallet gave the results of a minute chemical and optical examination of crystals of Blödite, and Mr. Henderson described a new mode of occurrence of Apophyllite in South Africa. A very noteworthy addition to the Number is Mr. Spencer's alphabetical list of the Mineral Species which have been named since the issue of the last edition (1892) of Dana's *System of Mineralogy*. An elaborate Index, compiled by Mr. Spencer, brings Volume XI. to a conclusion.

Number 54 contains information from Mr. Spencer about Augelite from a new locality in Bolivia. The same author, collaborating with Mr. Prior, proves that the mineral, long supposed to be a crystallised form of Brongniardite, is really a stanniferous Argyrodite. Mr. Herbert Smith, in a paper which we may hope to be followed by many others, contributes to our knowledge of Atacamite. Dr. Hussak describes a new mineral from Brazil, Senaite, belonging to the Ilmenite group, the analysis being by Mr. Prior, who in a subsequent paper critically discusses the existence of the species named Sphærostilbite. For the Abstracts which appear in the two Numbers the Society is indebted to the patient industry of Mr. Spencer and Mr. Herbert Smith.

The Council has to congratulate the Society on the continued steady sale of the Journal.

The Report of the Council was adopted.

The Elections of MM. Fouqué and Lévy as Corresponding Members and of Messrs. De Castro and Dickson as Ordinary Members were announced.

Messrs. Barlow and Hutchinson, having been nominated by the President to act as scrutators of the voting papers for the election of Officers and Council, reported that 59 ballot-papers had been returned, and that the Officers and Council nominated have been elected, namely :—

President.	Prof. A. H. Church, M.A., F.R.S.
Vice-Presidents.	Prof. G. D. Liveing, M.A., F.R.S.
	Mr. Hugo Müller, Ph.D., F.R.S.
Treasurer.	Mr. F. W. Rudler, F.G.S.
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	Mr. J. J. H. Teall, M.A., F.R.S.
	Mr. A. E. Tutton, M.A., A.R.C.S., F.C.S.
	Prof. W. W. Watts, M.A., F.G.S.

A vote of thanks to the Auditors, Mr. J. H. Collins and Mr. B. Kitto, was passed, and the Auditors were re-elected.

A vote of thanks to the retiring Officers and Council was proposed by Professor Miers and seconded by Dr. Müller, and was carried with acclamation. The retiring President, Professor Maskelyne, expressed his gratification at the way in which the motion had been received.

A vote of thanks to the Geological Society for the use of its Apartments was carried.

The following papers were read :—

1. Plagionite, Heteromorphite and Semseyite as Members of a Natural Group of Minerals : by Mr. L. J. Spencer : with chemical analyses by Mr. G. T. Prior (page 55).

2. Petrographical Notes on rock-specimens collected during the Ross Antarctic Expedition of 1839-43 : by Mr. G. T. Prior (page 69).

3. Mineralogical Notes from the Oxford University Laboratory : communicated by Prof. H. A. Miers (page 111).

4. Note on the occurrence of Riebeckite in trachytic rocks from Abyssinia: by Mr. G. T. Prior (page 92).

5. Mineral Deposits of the Binnenthal: by Mr. R. H. Solly.

EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, January 31st, 1899.

Prof. A. H. Church, M.A., F.R.S., President, in the Chair.

Mr. J. Currie, M.A., F.R.S.E., and Mr. C. G. Cullis, B.Sc., were elected Ordinary Members of the Society.

The resignation of Mr. T. Warburton was announced.

The Auditors' Balance Sheet for the year ending December 31st, 1898, was submitted and approved.

GENERAL MEETING.

Held in the Apartments of the Geological Society, January 31st, 1899.

Prof. A. H. Church, M.A., F.R.S., President, in the Chair.

Twenty-one Members and four Visitors were present.

The following papers were read:—

1. On a new mode of occurrence of Ruby, in North Carolina: by Prof. J. W. Judd, C.B., LL.D., F.R.S., and Mr. W. E. Hidden, F.G.S.; with crystallographic notes by Dr. J. H. Pratt.

2. Experiments with Zeolites: by Prof. A. H. Church, F.R.S., President.

3. Analyses of Ceylon Apatite: by Prof. A. H. Church, F.R.S., President.

4. On the constitution of the Mineral Arsenates and Phosphates. II. Pharmacosiderite: by Mr. E. G. J. Hartley.

5. On the specific identity of Binnite and Tennantite: by Mr. G. T. Prior and Mr. L. J. Spencer.

Prof. Church exhibited blue Apatites from Ceylon, one containing as much as 3·21 per cent. of chlorine, others only 0·63 and 0·34 per cent. He stated that the action of silver nitrate on Phillipsite is analogous to that investigated by Eichhorn and Lemberg in the case of salts on other zeolites.

Mineralogical Society—Abstract of Receipts and Payments from 1st January to 31st December, 1898.

RECEIPTS.	£ s. d.	£ s. d.
Balance from year 1897		78 0 6
Subscriptions:—		
(1) In advance	1 1 0	
(2) Current	40 18 10	
(3) In arrear	29 8 0	
		71 7 10
		23 2 0
Entrance Fees and Compositions		
Sale of Publications:—		
(1) From Publishers	11 7 6	
(2) In Office	9 9 11	
		20 17 5
		10 14 2
Dividends on Stock		
		£204 1 11

PAYMENTS.	£ s. d.	£ s. d.
Printing and Stationery		87 12 9
Illustrations		2 4 0
Attendants' Fees at Meetings		1 1 6
Secretarial Postage for 1897		1 4 1
Commission on Cheques		0 2 6
Investments and Brokers' Commission		10 14 2
Balance at Bank	£100 9 7	
,, in Office	0 13 10	
		101 3 5
		£204 1 11

Examined and compared with the vouchers and found correct. (Signed) BENEDICT KITTO, J. H. COLLINS, } *Auditors.*

January 26th, 1899.

LIABILITIES.	£ s. d.
Secretarial Postage for 1898	0 16 9
Excess of Assets over Liabilities	608 2 11
	£608 19 8

ASSETS.	£ s. d.
Balance as above	101 3 5
Subscriptions unpaid	23 2 0
Stock in 2¾ Consols: £408 18s. 4d., valued at 111	453 17 11
Dividend on Stock, January 1899	2 14 4
Sale of Journal, 1898 (estimated)	12 0 0
Due for Authors' Copies	16 2 0
	£608 19 8

The number of Life-Members on December 31st, 1898, was 46.

MEMO.—The Stock of Publications and value of the Library are not included in the above assets.

(Signed) F. W. RUDLER,
Treasurer.

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THE MINERALOGICAL MAGAZINE
AND
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OF THE
MINERALOGICAL SOCIETY.

No. 55. APRIL, 1899. Vol. XII.

Plagionite, Heteromorphite and Semseyite as Members of a Natural Group of Minerals.

By L. J. Spencer, M.A., F.G.S.,
With Analyses by G. T. Prior, M.A., F.G.S.,
Assistants in the Mineral Department of the British Museum.

[Read November 15th, 1898.]

In a recent number of this Magazine (1897, XI. p. 192) a paper by me on "The Crystallography of Plagionite" gives the results of goniometric measurements and specific gravity determinations made on crystals of plagionite from Wolfsberg in the Harz; it was also suggested on crystallographic grounds that the mineral from Arnsberg in Westphalia described by Pisani as heteromorphite was identical with plagionite: but as no quantitative chemical analyses were made on the material measured, these results were not altogether satisfactory.

Three specimens, which on account of their crystalline form and qualitative chemical composition were at that time considered to be plagionite, were therefore selected for further examination, with the result that only one of them was found to agree also in quantitative chemical composition and specific gravity with the original plagionite: of the two others, one agreed in these respects with Pisani's determinations for heteromorphite, and the other with semseyite.

These three minerals, therefore, although apparently the same, or nearly the same, in crystalline form, differ considerably in the proportions of lead to antimony which they contain.

In the first three sections below, each of the three specimens is described in detail, and in a fourth section the relations between them are discussed.

I. Plagionite from Wolfsberg in the Harz.

This specimen is a small confused group of bright crystals, without matrix; it has already been mentioned in the Magazine (XI. p. 194) as weighing 2·6642 grams and having a specific gravity of 5·57. On the surface are a little reddish-brown "tinder ore" and one or two very minute brittle needles, possibly of stibnite.

The colour of the mineral is iron-black, with perhaps a tendency to lead-grey; bright metallic lustre; opaque. The streak is black and in part shining (or, on unglazed paper, dull). The fracture is uneven, and there is a good cleavage parallel to $n\{111\}$. Brittle; hardness $=2\frac{3}{4}$.

The crystals are well developed, and the largest is about 7 mm. across. They are tabular in habit (Fig. 1), being flattened parallel to the basal plane $c\{001\}$; other important forms are the large negative pyramids $\{hhl\}$, and the smaller orthopinacoid $a\{100\}$, all of which are deeply striated and rounded parallel to their intersections with the basal plane, as is invariably the case in plagionite. These crystals were, therefore,

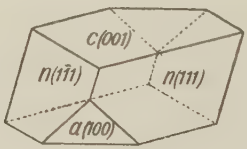

Fig. 1

badly adapted for measurement, but they were the best that could be sacrificed for combined crystallographic and chemical examination; they were comparatively large, apparently pure, and free from any drusy surfaces. The forms on the best crystal were determined by the approximate measurements to be: $c\{001\}$, $a\{100\}$, $e\{112\}$, $l\{223\}$, $n\{111\}$, $x\{221\}$, $m\{110\}$, also narrow, badly defined, positive pyramids $\{hhl\}$, rounded orthodomes near the positions of $\{\bar{7}01\}$, $\{\bar{7}02\}$ and $\{\bar{7}03\}$, and small indeterminable positive pyramids $\{\bar{h}kl\}$.

In collecting material for analysis, the cleavage and the striation of the faces were important guides. It was examined with a lens and under

the microscope, but no other mineral was detected. Attempts were made to measure each fragment which showed crystal faces; the following rather unsatisfactory angles were obtained from five fragments:—

	Calculated.[1]	Measured.
$ce = 001 : 112$	25° 40′	24½°, 26½°.
$cn = 001 : 111$	41° 8′	40°, 40½°, 42°, 42°, 42½°, 43°.
$cx = 001 : 221$	55° 54′	54½°, 56°, 56°, 56°, 56°.
$cm = 001 : 110$	78° 12½′	80°, 80°.
$ca = 001 : 100$	72° 28′	72°, 74°.

The specific gravity (weight of 1 cc.) of the material analysed was 5·50 at 22° C. The method of analysis was as previously used for andorite (this Magazine, 1897, XI. p. 290), the mineral being decomposed in a current of dry chlorine. The following results[2] were obtained by Mr. Prior on 0·6002 gram:—

		Atomic ratios.		Calcd. for $9PbS.7Sb_2S_3$.
Pb	41·24	·2008	9	41·29
Sb	37·35	·3125	14·01	37·38
S	21·10	·6629	29·7	21·33
	99·69			100·00

These results agree closely with the formula $9PbS.7Sb_2S_3 = Pb_9Sb_{14}S_{30}$. This is midway between the original formula $4PbS.3Sb_2S_3$, given by H. Rose in 1833 for plagionite, and that now usually accepted, namely, $5PbS.4Sb_2S_3$, which was proposed by Rammelsberg in 1860 (*Min -chem.*, p. 68). The previous analyses of Wolfsberg plagionite are quoted on p. 65, where the calculated percentage compositions are also given.

II. Heteromorphite from Arnsberg in Westphalia.

This mineral has already been mentioned in the Magazine (1897, XI. pp. 194-5), where it is stated that "the curved, indistinct crystals were found on measurement to be plagionite. One of the three crystals measured showed the forms *c a p e n*." Pisani,[3] who first described the mineral, stated that the crystals, from their appearance and qualitative chemical composition, were at first considered to be plagionite; but when

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[1] G. Rose, *Pogg. Ann.* 1833, XXVIII, 421.

[2] The atomic weights used in this paper are those given by F. W. Clarke (*Smithsonian Miscell. Collections*, 1897, No. 1075). Here Sb = 119·52 and Pb = 205·36, these being slightly lower than the values usually adopted. Previous to 1855, Sb was taken as 129, which accounts for some of the differences in the old formulæ.

[3] *Comptes Rendus*, 1876, LXXXIII. 747.

his quantitative analyses gave the formula $7PbS.4Sb_2S_3$, he concluded that the mineral could not be plagionite, and he then considered it to be crystallised heteromorphite, as forming probably a species distinct from jamesonite.

Here, owing to confusion of terms, it will be well to give a short historical review of jamesonite and heteromorphite. The prismatic Cornish mineral with a perfect end-cleavage was first noticed by Mohs in 1820; Haidinger in 1825 measured the prism angle, and gave the name jamesonite; and H. Rose in 1826 found the formula to be $3PbS.2Sb_2S_3$. In 1829 Rose found the federerz (feather ore) of Wolfsberg, which had previously been considered as stibnite, to have the formula $2PbS.Sb_2S_3$. This he established as a new species distinct from jamesonite. Twenty years later (1849) Zincken and Rammelsberg described a compact mineral from Wolfsberg also having the formula $2PbS.Sb_2S_3$, which they considered to be identical with Rose's federerz, but this name being inappropriate for their compact variety, they proposed the new name heteromorphite. Jamesonite and heteromorphite (=federerz) remained as distinct species until 1860, when Rammelsberg united them under the name jamesonite with the formula $2PbS.Sb_2S_3$; Rose's original formula, $3PbS.2Sb_2S_3$, being explained as due to the presence of admixed stibnite. This has since been followed in all the text-books.[1]

Zincken and Rammelsberg gave no reasons, beyond the similarity in chemical composition, for the statement that their compact mineral was identical with federerz, and indeed it may really have belonged to the plagionite-semseyite group rather than to the dimorphous group of acicular minerals into which zinckenite, jamesonite, plumosite (=federerz), boulangerite, and possibly meneghinite, may be provisionally brought together. The compact nature with platy separation, and the absence of iron (which is always present in plumosite and jamesonite to the extent of 2–3 per cent.) perhaps favour the latter view. If this be correct, then Pisani was justified in applying the name heteromorphite to the plagionite-like mineral from Arnsberg; and under the circumstances it seems best to follow him in the use of the name, even although it cannot be definitely proved that the heteromorphite of Pisani is identical with the heteromorphite of Zincken and Rammelsberg.

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[1] As a result of this the old jamesonite formula $3PbS.2Sb_2S_3$ has been forgotten, but has turned up again under the later names warrenite and domingite! We are at present examining these minerals, and have already made an analysis of measured crystals of Bolivian jamesonite, which, as in previous cases with crystallised and cleavable jamesonite, does *not* give the formula $2PbS.Sb_2S_3$.

It therefore seemed necessary to make an analysis on material of which the crystallographic data had been determined. The Arnsberg specimen selected for this purpose was one of the two previously examined. It consists of a fairly large mass of compact material, the cavernous surface of which is covered with numerous small crystals in crystallographic continuity with the massive material below. The massive material is crystalline throughout, as shown by the numerous cleavages on the fractured surfaces, and to all appearance it is the same substance as the crystals. The only other minerals on the specimen are one or two small isolated crystals of black blende and an embedded angular fragment of black quartzite.

The plagionite-like mineral is dull iron-black, but crystals in freshly opened cavities have a bright metallic lustre; the streak is black, and in part shining; H. $=2\frac{3}{4}$.

Although the crystals are small (about 1 mm. across) and indistinct, yet there is no mistaking the peculiar habit, striation of the faces, and good cleavage, so characteristic of plagionite. Few if any are tabular parallel to the basal plane, as is often the case in the Wolfsberg plagionite,

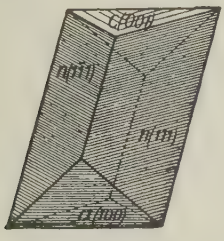
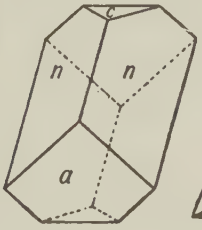


Fig. 2.



Fig, 3.

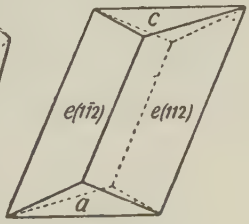


Fig. 4.

but they are elongated in the direction of the pyramid edges [hkl, $h\bar{k}l$] as shown in Figs. 2—4.[1] The striations and roundings are the same as before, but much more pronounced; and, owing to the grouping of the crystals in more or less parallel position, the zone of pyramids and the orthopinacoid are more often twisted than simply rounded, as in the saddle-shaped crystals of dolomite. The basal plane is usually smoother, but is often represented by different areas which are inclined at several

[1] Pisani (*loc. cit.*) describes the habit of the crystals as resembling that of mispickel, with an obtuse dome, or of adularia with $c\{001\}$ and $x\{\bar{1}01\}$, with deeply striated summits and oblique striations on the prism faces. He also mentions that the system is probably monosymmetric.

degrees to each other. It was therefore very difficult to obtain any satisfactory measurements; only eight of the numerous fragments placed on the goniometer gave any results at all.

	Calculated.		Measured.
	Plagionite.	Semseyite.	
001 : 114	$cp = 14° 12'$	$17° 50\frac{1}{2}'$	14°.
001 : 112	$ce = 25° 40'$	$30° 58'$	28°5′, 32°1′, 32°31′, 32°51′, $32\frac{1}{2}°$ (or 34° 0′).
001 : 111	$cn = 41° 8'$	$cp = 46° 35'$	40°50′ or 43°3½′ (cleavage; *c* gives a double image), 41°12′ or 46°18′, 40°57′, 44°56′, 44° or 45°.
001 : 100	$ca = 72° 28'$	$ca = 71° 4'$	71°27′, 72°.
111 : $1\bar{1}1$	$nn' = 59° 11'$	$pp' = 66° 19'$	65°, 65° (cleavage).

Although these measurements are very bad, varying in some cases more than 5°, still they show that the angles of the Arnsberg mineral are of the same general character as the angles of plagionite; and on this account the mineral was previously referred to plagionite.

The material collected for analysis consisted only of crystals and the crystalline material directly in contact with them, and was all taken from the free surface of the specimen. The results obtained by Mr. Prior with 0·5677 gram are given below. Iron and arsenic were absent. Specific gravity of the material analysed = 5·73 at 23° C.

		Atomic ratios.		Calcd. for $11PbS.6Sb_2S_3$.
Pb	48·89	·2381	11	48·93
Sb	31·08	·2600	12·02	31·07
S	19·36	·6082	28·1	20·00
Zn	0·18			
Cu	0·10			100·00
	99·61			

This analysis agrees with Pisani's determinations (see p. 65), though the lead is one per cent. higher than found by him. Pisani gave the ormula $7PbS.4Sb_2S_3$; as shown by Rammelsberg (*Min.-chem.* 1886, p. 138), his analysis agrees better with $9PbS.5Sb_2S_3$. The above analysis gives $11PbS.6Sb_2S_3 = Pb_{11}Sb_{12}S_{29}$, but the sulphur is rather low.

III. Semseyite from Wolfsberg in the Harz.

The specimen described in this section was selected for analysis on account of the high specific gravity 5·99 (as determined with the

hydrostatic balance for the group of crystals weighing 10·6430 grams). This also had been catalogued with the plagionites; the high specific gravity being, at the time, thought to be possibly due to a kernel of some heavier mineral, such as galena.

No matrix is present, but there is a little reddish "tinder ore" and "feather ore"[1] on the surface, and in a few small crevices in the interior. Although the mass was broken open and submitted to very careful examination, these were the only minerals found.

The crystals of the plagionite-like mineral are much larger (averaging 1 cm. long) than observed on any of the other specimens which have been catalogued as Wolfsberg plagionite. They are grouped for the most part in more or less parallel position, and are of the habits shown in Figs. 2—4 (p. 59). The crystals, although very distinct in form and habit, are sometimes distorted and twisted, even more so than in the Arnsberg mineral; further, the surfaces are rough and drusy, and the whole appearance of some of the crystals points to their being built up of smaller individuals in radiated rather than in parallel position. Of the forms which can be distinguished: $c\{001\}$ is the most even, but is usually small and sometimes absent; $a\{100\}$ is very rough, and often rounded in two directions; the pyramids are sometimes fairly even, and the thicker and the flatter prismatic habits shown in Figs. 2 and 4 respectively are easily to be distinguished. At other times the pyramids merge into each other and the basal plane, forming a twisted surface. The striations are the same as before.

Attempts were made to measure several crystals and fragments, but variations of over 10° were obtained, and no definite angle can be given. The most satisfactory measurements were obtained from the pyramids across the plane of symmetry. This angle $(hhl):(h\bar{h}l)$ gave various values between the extremes 33° and 82°.

The colour of the mineral is iron-black, with dull metallic lustre, which however is brighter on fresh fractures; the streak is black and in part shining. The mineral is brittle; H. $=2\frac{3}{4}$. The pyramidal cleavage is good, and the fracture uneven, with sometimes a more or less granular appearance. The difference between the more or less even cleavage surfaces and the uneven fractures with the granular appearance is more marked when fragments, illuminated with the aid of a Lieberkuhn, are examined under the microscope. Beyond this difference there was

[1] In matted fibres, which are straight and not flexible; it contains lead, antimony and sulphur.

nothing that suggested the presence of more than one kind of mineral, and this is not inconsistent with the material being all of one kind, since the cleavage does not give a closed form.

The material collected for analysis gave sp. gr. = 5·92 at 22° C. for the fine powder. In the following analysis by Mr. Prior, the antimony and lead were determined by decomposing 0·6953 gram of the mineral in chlorine, and the sulphur by fusing another portion weighing 0·3278 gram with sodium carbonate and potassium nitrate.

		Atomic ratios.		Calcd. for $21PbS.10Sb_2S_3$.
Pb	51·84	·2524	21·06	51·79
Sb	28·62	·2395	20	28·71
S	19·42	·6100	50·94	19·50
	99·88			100·00

This agrees closely with the formula $21PbS.10Sb_2S_3 = Pb_{21}Sb_{20}S_{51}$. Both the lead and the antimony differ by about one per cent. from the amounts required by the formula $2PbS.Sb_2S_3$ (see p. 65).

This mineral, then, although closely resembling plagionite and the Arnsberg mineral in appearance and crystalline form, contains 10 – 11 per cent. more lead than the former, and 3 per cent. more than the latter, whilst it contains only 1·3 per cent. less lead than semseyite.

The name semseyite was given by Prof. J. A. Krenner[1] to small, grey, tabular crystals from Felsőbánya in Hungary, which are strikingly similar to the Wolfsberg plagionite[2] in appearance, habit and cleavage, but differ from it in the proportion of lead to antimony, the specific gravity, and also slightly in the crystal angles. Analysis by L. Sipőcz gave the formula $7PbS.3Sb_2S_3 = Pb_7Sb_6S_{16}$; sp. gr. = 5·9518. Only three measured angles are given, but these do not agree with the parameters[3] as given by Krenner, and it is difficult to know exactly what value to attach to them.

The crystals described in this section may then be called semseyite, since they agree with this in chemical composition, specific gravity, and in the habit and cleavage. Also the approximate measurements, 33° and

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[1] *A Magyar tudományos Akadémia Értesitöje*, Budapest, 1881, XV. 111–3. German abstracts are given in *Zeits. Kryst. Min.* 1884, VIII. 532–3, and *Ungarische Revue*, 1881, p. 367.

[2] In fact, the specimens appear at one time to have been labelled as plagionite, since M. Tóth (*Minerals of Hungary*, Budapest, 1882, p. 385) gives plagionite from Felsőbánya, on the authority of the Hungarian National Museum.

[3] The parameters and angles calculated by Dana from Krenner's three measured angles are here adopted.

82°, given above, are near to $ss'(113 : 1\bar{1}3) = 33°50'$ and qq' $(221 : 2\bar{2}1)$ $= 81°2'$ of semseyite. The corresponding extreme plagionite angles are: pp' $(114 : 1\bar{1}4) = 21°14'$ and yy' $(331 : 3\bar{3}1) = 83°29'$; also ee' $(112 : 1\bar{1}2) = 37°57'$.

Another specimen of Wolfsberg "plagionite" consists of numerous small crystals of the same habit as the above: they are, however, much more distorted and less distinct, and form globular aggregates,[1] the surfaces of which are defined by the rounded and striated orthopinacoids $a\{100\}$. Penetrating the whole group are one large, and several smaller, thin-tabular crystals of bournonite. On the surface of the specimen are small quantities of "tinder ore" and a few minute crystals of copper pyrites and calcite. The specific gravity of the whole group (weighing 29·4529 grams) is 5·99. Since all the accompanying minerals have specific gravities lower than this, the plagionite-like mineral must have a specific gravity slightly higher.[2] Qualitative analysis showed the presence of only lead, antimony and sulphur. On one small fragment the angle from the basal plane to the cleavage was measured as 46°49', also for the natural faces $cp = 47°$. This specimen is therefore semseyite. Curiously enough, this specimen, and another with isolated crystals of the same prismatic habit on a matrix of quartz, were acquired by the British Museum (from Dr. Fischer in 1864) labelled as crystallised heteromorphite of Rammelsberg.

IV. The Relations of the Plagionite-Semseyite Group.

As already stated, both Pisani and Krenner had remarked on the great similarity of the crystals of the Arnsberg heteromorphite and of semseyite with those of the Wolfsberg plagionite. The form, striation of the faces, and cleavage are the same for all three minerals, and the approximate measurements which could be obtained from the material described above are not sufficient to distinguish between them. Pisani gave no measurements, and the data given by Krenner for semseyite only differ essentially from the plagionite constants in the greater length of the vertical axis, in the ratio of 4 : 3.

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[1] Such globular aggregates of "plagionite" from Wolfsberg have already been described by Kenngott (*Sitz.-ber. Akad. Wien*, 1855, XV. 236; XVI. 160). He also gives figures illustrating the prismatic habit.

[2] Taking the sp. gr. of bournonite to be 5·8, and estimating its volume (about 1cc.) by measuring the size of the crystals, the sp. gr. of the semseyite is calculated as about 6·0.

	a : b : c	β	c : 111 (cleavage).
Plagionite[1] ...	1·1361 : 1 : 0·8410	72°28′	41° 8′
Semseyite ...	1·1442 : 1 : 1·1051	71° 4′	46°35′

Since the chemical composition and specific gravity of the Arnsberg heteromorphite are between those of plagionite and semseyite, it might be expected that the vertical axis should also have some intermediate value. The measurements given above (p. 60) are however too unsatisfactory to show whether this is the case or not, but some of these angles lie between the corresponding plagionite and semseyite values.

The corresponding forms occurring on the three minerals are compared in the following table. All the observed heteromorphite and semseyite forms, but not all the plagionite forms, are given. The parametral plane is the direction of good cleavage for all.

Plagionite	$c001$	$a100$	$p114$	—	112	$n111$	$x221$	—	$s\bar{1}12$
Heteromorphite	$c001$	$a100$	$p114$	—	$e112$	$n111$	—	—	—
Semseyite	$c001$	$a100$	—	$s113$	—	$p111$	$q221$	$t\bar{1}13$	—

The crystals of plagionite, heteromorphite and semseyite described above show a difference in habit, in the first being tabular (Fig. 1), and in the last two prismatic (Figs. 2—4). The plagionite crystals measured by Rose and Luedecke, and most of the crystals of which measurements have previously been given in this Magazine, were also tabular in habit. But it is doubtful whether this difference in habit is sufficient for purposes of discrimination. Most crystals are unsuitable for accurate measurement, so that the only methods of determination are quantitative analysis or to take the specific gravity. The crystals are, however, usually small and scattered over a matrix of quartz, &c., and to collect sufficient material for their determination would mean the destruction of the rare specimens.

In order to compare the chemical composition of members of the group, all the published analyses are brought together and arranged below according to the percentage of lead. Zincken and Rammelsberg's heteromorphite from Wolfsberg has also been added for the reasons stated above (p. 58).

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[1] G. Rose's parameters (*Pogg. Ann.* 1833, XXVIII. 421) are here given, since they were presumably determined on the same material as analysed by his brother, H. Rose. Luedecke's (1883) measurements were not made on analysed material.

			Pb.	Sb.	S.		Total.	Sp. gr.
Plagionite.	Schultz (1860)	Wolfsberg	39·36	37·84	21·10	Cu 1·27	99·57	—
	Rose (1833)[1]	,,	40·52	37·94	21·53		99·99	(5·4)
			40·62	—	21·89			
	Kudernatsch (1836)	,,	40·81					
	Crystals		40·98	[37·53]	21·49		100·00	
	Prior (p. 57)	,,	41·24	37·35	21·10		99·69	5·50
Heteromorphite.	Pisani 1876)[2]	Arnsberg	47·86	31·20	19·90	Zn 0·60	99·56	5·59 to 5·73
			48·1					
	Poselger (1847)[3]	Wolfsberg	48·48	32·98	20·32		101·78	5·68
	Prior (p. 60)	Arnsberg	48·89	31·08	19·36	Cu 0·10, Zn 0·18	99·61	5·73
Semseyite.	Prior (p. 62)	Wolfsberg	51·84	28·62	19·42		99·88	5·92
	Sipőcz (1881)[4]	Felsőbánya	53·16	26·90	19·42	Fe 0·10	99·58	5·95

Although these analyses fall into three well-marked groups, yet they are all different, and none of them give simple formulæ. The calculated percentage compositions corresponding with the various formulæ are added for comparison with the analyses. $2PbS.Sb_2S_3$ is also given, but it agrees with none of the analyses.

		Pb.	Sb.	S.	Pb. : Sb.
Plagionite.	$5PbS.4Sb_2S_3 = Pb_5Sb_8S_{17}$ ...	40·68	37·88	21·44	1 : 1·60
	$9PbS.7Sb_2S_3 = Pb_9Sb_{14}S_{30}$	41·29	37·38	21·33	1 : 1·55
	$4PbS.3Sb_2S_3 = Pb_4Sb_6S_{13}$ ...	42·07	36·73	21·20	1 . 1·50
Heteromorphite.	$7PbS.4Sb_2S_3 = Pb_7Sb_8S_{19}$ ...	47·94	31·89	20·17	1 : 1·14
	$9PbS.5Sb_2S_3 = Pb_9Sb_{10}S_{24}$...	48·54	31·39	20·07	1 : 1·11
	$11PbS.6Sb_2S_3 = Pb_{11}Sb_{12}S_{29}$	48·93	31·07	20·00	1 : 1·09
	$2PbS.Sb_2S_3 = Pb_2Sb_2S_5$ ...	50·77	29·55	19·68	1 : 1
Semseyite.	$21PbS.10Sb_2S_3 = Pb_{21}Sb_{20}S_{51}$	51·79	28·71	19·50	1 : 0·95
	$9PbS.4Sb_2S_3 = Pb_9Sb_8S_{21}$ ...	53·22	27·53	19·25	1 : 0·89
	$7PbS.3Sb_2S_3 = Pb_7Sb_6S_{16}$ ...	53·96	26·92	19·12	1 : 0·86

[1] *Pogg. Ann.* XXVIII. 422. The two analyses were made on crystals from different specimens (Berzelius' *Jahresber.* 1835, XIV. 173; *Pogg Ann.* 1835, XXXV. 362).

[2] *Loc. cit.* (*a*) Mean of three analyses on selected crystalline material; (*b*) on massive material, after deducting 7 per cent. of blende.

[3] Rammelsberg's *Handwörterb. chem. Min.* 1847, 3rd Suppl., p. 44. This is the massive heteromorphite described by Zincken and Rammelsberg, *Pogg. Ann.* 1849, LXXVII. 240. Compare Rammelsberg's *Handb. Min.-chem.* 1860, p. 71, where different figures are given: a second analysis is given here, which agrees more closely with $2PbS.Sb_2S_3$.

[4] On crystals: Krenner (*loc. cit.*). A more detailed account of this analysis is given by Sipőcz in *Tscherm. Min. Mitth.* 1886, VII. 283.

In attempting to explain the relation between these minerals, three suggestions present themselves:

(1). That the crystals may enclose galena.

(2). That there may be isomorphous mixing of two end members, as in the plagioclase and scapolite groups.

(3). That the three minerals may be members of a morphotropic series, in which the vertical crystallographic axis increases in length with an increase in the amount of lead.

While examining and selecting material for the three analyses, the first suggestion was kept constantly in view, but no indications of the presence of galena could be found. Unless it were very finely disseminated, it would, on account of the lead-grey colour and perfect cleavage, be easily detected under a microscope fitted with accessories for illuminating opaque objects; further, all the British Museum specimens from Wolfsberg and Arnsberg were carefully examined, but no galena could be found on any of them; moreover, galena is not a mineral recorded from the antimony (stibnite) mines at Wolfsberg and Arnsberg. The semseyite from Felsőbánya (and Rodna), however, occurs as small crystals coating corroded galena, and in this case it would not be easy to collect material entirely free from galena. The presence of any galena might be detected by the action of suitable solvents; hydrochloric acid, however, would not do, since it decomposes both plagionite and galena. Also if the variation in composition were due to enclosed galena, there would then be no variation in the crystalline form, as is shown (but perhaps not absolutely proved) to be the case by Krenner's measurements.

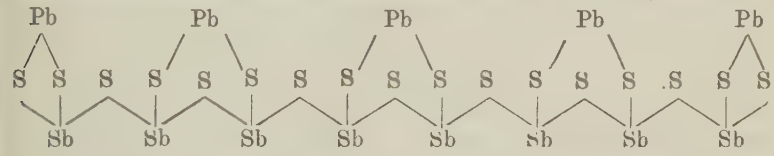
The second suggestion is rather supported by the gradual variation in composition and by the absence of any simple formula, but it would not explain why the analyses fall into three fairly well-marked groups. The two unknown end members would presumably have more simple formulæ than the extremes given above, and they would probably show a wider variation in the parameter c than now shown. But the difference in the angles of the members already known is greater than is the rule in isomorphous substances, and certainly considerably greater than in the plagioclase and scapolite groups.

On the whole, the third suggestion, that of a morphotropic series, seems the most probable. Amongst minerals, the only morphotropic series yet established is that of the humite group[1]; it has also been

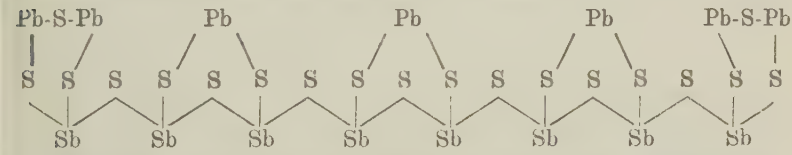
[1] *Min. Mag.* 1896, XI. 137, 161.

suggested that andorite, diaphorite and freieslebenite form such a series.[1] In both these cases the crystals of members of each group are so similar in appearance that they cannot be distinguished by mere inspection, and the only essential difference between them is in the greater length of the vertical axis, which varies regularly with the chemical composition, while the parameters $a : b$ remain practically constant. This is exactly the relation existing between plagionite and semseyite.

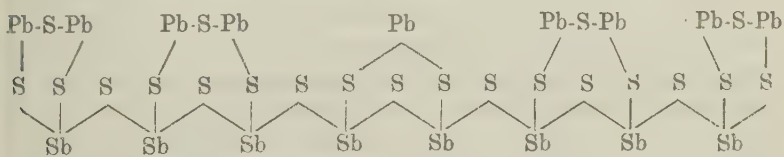
In these cases the comparison of structural formulæ is suggestive, and such formulæ have been given for chondrodite, humite and clinohumite by Sjögren and F. W. Clarke. The following structural formula for plagionite ($5PbS.4Sb_2S_3$) has recently been given by V. C. Buturcanu[2]:



Replacing two of the —Pb— atoms by the groups —Pb—S—Pb—, the heteromorphite formula $7PbS.4Sb_2S_3$ is obtained:



Introducing four such groups, we get the formula $9PbS.4Sb_2S_3$, and this agrees better with the analysis of the original semseyite than does the formula $7PbS.3Sb_2S_3$ given by Krenner.



These formulæ are symmetrical, and the manner in which new atoms of lead are introduced suggests a relation with the increase in the vertical axis of the monosymmetric crystals. Two other possible formulæ in the same series are $8PbS.4Sb_2S_3 = 2PbS.Sb_2S_3$ and $10PbS.4Sb_2S_3$.

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[1] L. J. Spencer, "Diaphorite from Washington and Mexico," *Amer. J. Sci.* 1893, VI. 316.

[2] *Bull. Soc. Sci.* Bucarest, 1897, VI. 179.

An objection to this is that only a few of the analyses agree exactly with the three formulæ, $5PbS.4Sb_2S_3$, $7PbS.4Sb_2S_3$ and $9PbS.4Sb_2S_3$, and, in fact, almost every analysis requires a different formula. Since isomorphous mixture has been provisionally rejected, another explanation must be given for this variation in composition.

The only crystals which have as yet given satisfactory measured angles are those of the extreme members with the formulæ $5PbS.4Sb_2S_3$ and $9PbS.4Sb_2S_3$. Other crystals are very imperfect, and opposite planes of the same form are never quite parallel; they appear, in fact, to be built up of smaller crystals whose crystallographic elements are not quite the same, so that the compound crystals, although having the same habit as the smaller crystals, are distorted and twisted. The smaller crystals may be supposed to have definite compositions, as given by the three formulæ above; the bulk analysis of a compound crystal would then give an indefinite formula, e.g. the formula $21PbS.10Sb_2S_3$ in section III. This is perhaps supported by the specific gravity determinations in sections I and III; in both cases the sp. gr. of the material analysed was slightly less than for the whole group. Pisani also found variations in the specific gravity.

It is possible that other twisted crystals may be explained in the same way: e.g. the saddle-shaped crystals of dolomite may be built up of smaller crystals containing different proportions of $CaCO_3$ and $MgCO_3$, and consequently with different crystal angles.

Besides the three localities mentioned above, viz. Wolfsberg, Arnsberg and Felsőbánya, plagionite-like minerals have been recorded from seven other localities; but as none of these have been properly determined, it is impossible to say whether they are plagionite, heteromorphite or semseyite.

Previous crystallographic determinations made on material not analysed now become of little value. The parameters given by me (*Min. Mag.* 1897, XI. 194) were calculated from the mean angles measured on the seven best crystals (from four specimens), and these, it is now seen, may have varied considerably in chemical composition. On these crystals the angle $c\,n = 001 : 111$ varied by 3°, and by more than 2° on one and the same crystal; the extreme means of the several readings for each crystal were 41°5′ – 41°45′. Although it still seems probable that these crystals were plagionite, and that the variations in the measured angles were due to the imperfections of the crystals rather than to differences in composition, it is nevertheless quite possible that some of the "new" forms (all determined on these seven crystals) may be reduced to forms already known when referred to the heteromorphite or semseyite axes.

Petrographical Notes on the Rock-specimens collected in Antarctic Regions during the voyage of H.M.S. Erebus and Terror under Sir James Clark Ross, in 1839-43.

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[Read Nov. 15th, 1898.]

Introduction.

THE rock-specimens collected during the Antarctic Expedition of 1839-43 were deposited in the British Museum. A few years ago, in the course of a re-arrangement and registration of the rock-specimens n the Museum, this collection amongst others was examined, and microscopic sections of some of the specimens were prepared. Nothing, however, was published at that time, since it was found that the greater part of the collection had been practically duplicated by the rocks of the *Challenger* Expedition, which had a year or two previously been deposited in the Museum, and it was felt that mere petrographical descriptions of specimens have but little to recommend them in the absence of geological data as to the mode of occurrence and mutual relations of the rocks in the field.

During the recent revival of interest in Antarctic exploration, however, inquiries were made regarding the rock-specimens collected by the Ross Expedition, and it was suggested by Sir John Murray that some petrographical description of them would at the present time be highly desirable. The following notes on the specimens collected in Antarctic regions have accordingly been prepared.

By far the greater part of the Ross collection consists of specimens from Kerguelen Land similar to those brought back by the *Challenger* Expedition. The latter have been fully investigated by Renard: the present paper is therefore confined to the description of the rocks collected in Antarctic regions during the three voyages southward made by the Expedition, starting from Tasmania, New Zealand, and the Falkland Islands respectively.

The Antarctic Expedition of 1839-43 was undertaken by the Government at the instigation originally of a Committee appointed by the British Association for the Advancement of Science at its eighth meeting, held at Newcastle in 1838. Its main object was to advance the Science of Terrestrial Magnetism by an extensive series of observations made in high southern latitudes. An account of the Expedition is given in *A Voyage of Discovery and Research in the Southern and Antarctic Regions during the years* 1839-43, by Sir James Clark Ross (London, John Murray, 1849); and also in *Voyages of Discovery in the Arctic and Antarctic Seas, &c.*, by Robert McCormick (London, Sampson, Low, 1884). McCormick was chief surgeon on board the *Erebus*, and was mainly responsible for the collection of the rock-specimens. In appendices to Ross's book he gives brief geological accounts of the various regions visited by the expedition; but unfortunately these so-called geological accounts in most cases resolve themselves into exasperating (from a petrological point of view) descriptions of birds, for the doctor appears to have been a more enthusiastic ornithologist than geologist.

The Expedition started from Chatham in September 1839, and after visiting Madeira, the Cape Verde Islands, St. Paul's Rocks, the little island of Trinidad off Brazil, and St. Helena, at all of which places magnetic observations were made and a few rock-specimens collected, arrived at the Cape of Good Hope in March 1840. Thence it proceeded to Kerguelen Land, and after spending two months on that desolate island, reached Tasmania in August. Here the Expedition remained until November, when a start was made on a voyage into Antarctic regions.

I. First Voyage Southward.

In the first voyage southward, the first land visited by the Expedition after leaving Hobart Town was the Auckland Islands.

(1.) *Auckland Islands.*

These islands, discovered in 1806 by Captain Bristow, are situated about 300 miles south of New Zealand, in about lat. 50° 32′ S. and long. 166° 12′ E.

According to McCormick they are volcanic, being constituted chiefly of basalt, which at Dea's Head, a promontory of Auckland Island, forms fine columns. These islands were used in 1874 by the German astronomers as the station for the observation of the transit of Venus. According to Hermann Krone, a member of this Expedition, the largest of the islands has an area of seven square miles; all of them are volcanic, and

consist of an older trachyte[1] formation succeeded by basalt; the highest hill, Mount Eden, is 404 metres high, and is crowned with a mass of basalt. A few rolled pebbles of basalt collected by Dr. Seeliger, another member of this expedition, have been described[2] by Max Hartmann. They were all felspar-basalts, mostly of coarse-grained doleritic structure; in one of the specimens the presence of nepheline is doubtfully recorded.

All the specimens from the Auckland Islands collected by the Ross Expedition are also of *felspar-basalt*, but of a fine-grained porphyritic rather than of doleritic type. Most of them consist of flat slabs (with brown weathered surfaces) of a bluish-grey fine-grained rock, showing large (up to 1 cm. in length) porphyritic crystals of black augite, and of perfectly fresh and transparent yellow olivine. Under the microscope, phenocrysts of pale purplish titaniferous augite and, in less amount, of olivine with a few labradorites are seen distributed in a fine-grained groundmass of felspar laths showing flow structure, magnetite, and pale green to purple granular augite. In one specimen the groundmass also contained small olivines.

The augite phenocrysts in some specimens have definite crystal outlines, and show octagonal sections bounded by prism and pinacoid faces, but in others they have been corroded and penetrated by the magma, and have rounded contours with a margin of alteration crowded with grains of magnetite. The pleochroism in basal sections was from purplish brown to yellowish brown; the extinction on cleavage flakes was nearly 40°; polysynthetic twinning on $a(100)$ was noted in several sections, and also hour-glass structure. Inclusions of magnetite and of groundmass were common; in one section very minute black needles arranged in two parallel sets inclined at an angle of about 60° were observed.

The olivine phenocrysts have slightly rounded outlines, and are very clear and fresh. Between crossed nicols inclusions can be seen in some sections of very minute star-like radiating groups of a strongly doubly refracting mineral. They remind one of the gypsum crystals obtained in microchemical reactions, and are thus very similar to the sahlite needles in the altered olivine of the Medenbach picrite recently described and figured by R. Brauns.[3] In the present case, however, from their small angle of extinction, I am inclined to refer them to tremolite. I have

[1] No specimens of this trachyte appear to have been collected by this German expedition, nor was one found in the Ross collection. Some uncertainty must therefore exist as to the nature of this older formation.

[2] *Neues Jahrb. f. Min. u. Petr.* 1878, pp. 825–30.

[3] *Neues Jahrb. f. Min. u. Petr.* 1893 (2), 179.

noted similar minute inclusions in the olivine of nepheline-basalts from Fernando Noronha.

The porphyritic felspars are small prismatic, and often occur in patches of several individuals. They show broad albite twin-lamination with symmetrical extinction of about 30°, so that they may be referred to labradorite; a few crystals, however, with zonal extinction appear to be of a more acid type.

The specific gravity of this rock was 2·85.

In general character the basalt approximates closely to some of the Bohemian felspar-basalts described by Boricky.

Another specimen less distinctly porphyritic, and apparently of more basic type than the preceding, was of a dark grey colour, and showed to the naked eye only small porphyritic olivines. Under the microscope it presents somewhat similar characters to those of the last rock, but the olivine phenocrysts are in far larger amount, and show along cracks and round the margin a green alteration product. The pale purple augite occurs generally in groups of several individuals, often in association with the olivine; in one case a large olivine crystal is completely surrounded by a border of augite grains. The felspar phenocrysts are in subordinate amount, and show all stages of absorption by the base. They are rounded and corroded, often into the most fantastic shapes; in some cases the groundmass has penetrated into them along definite channels, in other cases its constituents, magnetite and augite microliths, pervade them in such a way that they lose all definite outline.

Of a somewhat different type is a rock labelled "Oceanic Point." It is a dark grey basalt, not markedly porphyritic, but showing to the lens on the rough weathered surface small yellow olivines. Under the microscope the only phenocrysts are seen to be of olivine. These are small and clear, but are generally rounded, and are often penetrated by and include portions of the groundmass. This groundmass consists of lath-shaped crystals of labradorite (symmetrical extinction of about 25°), with much pale green to colourless granular augite and iron ores. The latter (in part probably ilmenite) is in rod-like skeleton crystals, generally wedged between the felspar-laths and obviously one of the last minerals to consolidate; in the neighbourhood of the olivine phenocrysts in some cases the rods (or plates) are arranged at right angles to the axis of the olivine, as observed by Reusch in basalts from Jan Mayen[1] and by Streng

[1] *Neues Jahrb. f. Min. u. Petr.* 1883 (2), 224.

in the Londorf dolerite.[1] This directional character is particularly marked in the case of patches of groundmass included in the olivines.

A specimen labelled "Pig Island" is a black compact basalt consisting of a very fine-grained felt of felspar laths, pale green augite microliths and much granular magnetite. Olivine occurs very sparingly in small grains, and a deep purple augite in minute prismatic crystals.

Finally, from Dea's Head is a basalt of a somewhat coarser-grained type than any of the preceding. It is a dark grey, slightly vesicular rock, showing to the lens small yellow olivines. These, under the microscope, are seen to occur in small idiomorphic crystals, some giving the usual hexagonal outlines, but others long prismatic and rod-shaped. All have a deep orange-red alteration product round the margin. Purple augite in prismatic crystals of varying size and often forming radiating groups is present in large amount, and is idiomorphic with respect to the small lath-shaped felspars which in subordinate amount form as it were the paste for the other constituents. Magnetite occurs in fairly large grains. One large irregular plate of ilmenite (?) enclosed crystals of felspar and purple augite.

(2.) *Campbell Island.*

Campbell Island, the next land touched by the Expedition, is about 120 miles S.W. of the Auckland Islands, in lat. 52° 33′ S. and long. 169° 8′ E. Hazelburgh, who discovered the island in 1810, states that it is 30 miles in circumference, and is mountainous. The hills, of which the highest has an elevation of 1,500 ft., were less wooded than those of the Auckland Islands.

According to McCormick, the geology of the island is very similar to that of the Aucklands. Pebbles of quartz and agate, however, and traces of limestone were found amongst the shingle on the beach, "the only indication of the sedimentary class of rocks which we met with after our departure from the Australian lands."

The specimens from Campbell Island consist of *basalt*, *silicified foraminiferal limestone*, and *chert*.

One large specimen of compact dark bluish gray porphyritic basalt presents both macroscopically and under the microscope almost precisely the same characters as those of the basalt from the Auckland Islands described on p. 71.

Another basalt specimen is very vesicular and of a coarser-grained type. Under the microscope crystals of purplish augite, altered olivines

[1] *Neues Jahrb. f. Min. u. Petr.* 1888 (2), 181.

with hexagonal sections and prismatic felspars, are seen in a medium-grained base of granular purple augite, felspar laths and skeleton growths of magnetite. The olivine and felspar are almost wholly converted into a green alteration product, while the purple augite remains perfectly fresh.

Of the sedimentary rocks referred to by McCormick there are three specimens. One of them is a small fragment of hard compact siliceous limestone labelled "Lime from a vein in basalt, South Harbour, Campbell's Island." A thin section shows that it consists largely of the remains of foraminifera (globigerina) in fairly good preservation. Treated with acid it effervesces strongly, but leaves a large siliceous residue. A partial quantitative analysis made on 0·7640 gram of this rock gave the following result:—

SiO_2	=57·46
$CaCO_3$ ...	=39·26
$MgCO_3$ ...	= 0·36
$Al_2O_3(+Fe_2O_3)$	= 1·48
H_2O, &c. ...	=(1·44)
	100·00

The specific gravity of the fragment was as low as 2·15.

To the kindness of Messrs. H. W. Burrows and R. Holland I am indebted for the following note, in which are enumerated the species of foraminifera identified by them in sections cut from this specimen:—

"This is a compacted *Globigerina* ooze of essentially modern character, certainly, in our opinion, not older than Post Pliocene.

"It is closely matched by the deposits now accumulating at other parts of the S. Pacific, and is very like some of the soundings in our own collection, notably those off Molyneux, and off Otago, New Zealand.[1]

"The *Foraminifera* are in a very fresh condition, and in this respect resemble those in a palagonite-tuff in Mr. C. W. Andrews' collection from Christmas Island.

"We have determined the following species in the two slides—

"v.r. *Pulvinulina Micheliniana*, d'Orb.

"v.c. *Globigerina bulloides*, d'Orb., spinose.

"v.c. *Globigerina bulloides*, var. *triloba*, Rss., spinose.

[1] The precise localities referred to are—Off E. of Otago, 953 faths. lat. 45°55′ S.; long. 172°46′8″ E. Off Molyneux, 614 faths. lat. 46°37′ S.; long. 171°2′7″ E.

"v.c. *Orbulina universa*, d'Orb.
"r. *Bulimina affinis*, d'Orb.
"r. *Bolivina* sp.

"The species are, doubtless, more numerous, as we notice fragments which are not referable to the above-named species, but they are not sufficiently distinct to be determinable."

The other two specimens are of chert, probably representing the final stages of the silicification of the limestone. One of them, of flinty hornstone-like appearance, shows under the microscope remains of globigerina, but in a far less perfect state of preservation than in the preceding specimen.

The third specimen has a more felsitic appearance, and is covered with small quartz crystals. No organisms can be definitely distinguished under the microscope.

(3.) *Possession Island.*

After leaving Campbell Island, the Expedition crossed the Antarctic Circle, and soon after became beset in the pack ice. Having passed through the pack, it emerged into an open sea, and, proceeding further southward, on January 11th, 1841, in about lat. 71° S. and long. 171° E., discovered Victoria Land, "rising steeply from the ocean," as described by McCormick, "in a stupendous mountain range, peak above peak, enveloped in perpetual snow." Some of these peaks attain an altitude of from 10,000 to 15,000 feet. From the dark colour of the rocks, where they broke through their icy covering, and from several black pebbles dredged up off the northern promontory, Cape Adare, Ross formed the opinion that the newly-discovered land was of volcanic origin.[1] The mainland could not be approached, but a landing was effected on a small island (Possession Island) lying off it in about lat. 71° 56′ S. and long. 171° 7′ E.

According to McCormick this island is composed of "volcanic conglomerate, vesicular lava, and basalt," rising to a height of about 300 feet. It showed not the smallest vestige of vegetation. McCormick describes the fantastic shapes assumed by the basaltic rocks, and mentions a cave showing fine columns, "a Fingal's cave in miniature."

The specimens labelled as from Possession Island include *basalts palagonite-tuff*, *phonolite* and fragments of *muscovite-granite*.

[1] According to Sir John Murray (*Proc. Roy. Soc.* 1898, LXII. p. 424) Borchgrevink and Bull have recently brought back fragments of mica-schist from Cape Adare. A nepheline-tephrite from the same locality has been described by Teall.

Basalts.

A scoriaceous black basalt, in which no porphyritic crystals could be distinguished with the naked eye, was seen under the microscope to consist of a very fine-grained dense almost opaque felt of magnetite grains, felspar laths, and minute colourless augite microliths, with here and there, very sparingly, rhombic sections of olivine showing generally a central inclusion of glass. The larger felspar laths, on one of which a symmetrical extinction angle about the twin lamellæ of 25° was measured (labradorite), marked the flow-structure of the rock. Small phenocrysts of a pale purple augite, showing inclusions of magnetite and olivine, occur sparingly.

An interesting feature is the presence of a few small phenocrysts of a deep brown basaltic hornblende. Some of these, in process of absorption by the base, are lenticular in shape, and are surrounded by a zone of magnetite grains. In one case this hornblende forms a zone round an irregular fragment of augite, as though of later date.[1]

In the hand-specimen a fragment of this hornblende, about 2 mm. cube, occurs loosely attached in a cavity, as if it had been caught up in the lava flow. Cleavage flakes from this fragment are only transparent when very thin, give almost straight extinction, and in convergent light show signs of both axial brushes, so that an optic axis is not very near the centre of the field as it is in the case of ordinary hornblende. The pleochroism was, in a cleavage flake, light yellow-brown to deep brown (almost black); in a section showing both cleavages, light yellow-brown for *a* and deep reddish-brown for *b*. The cleavage angle measured on the reflecting goniometer was 124° 34′.

A rolled pebble of compact black basalt, showing to the lens only a few minute phenocrysts of augite, presents under the microscope somewhat similar characters to those of the preceding rock, but is of coarser grain. The only phenocrysts are of a pale purple augite (generally with a green centre). Most of the sections have well-defined rectangular or octagonal crystal outlines, but some are corroded and surrounded by a zone of magnetite grains, and some show hour-glass structure. They generally enclose magnetite, and in some cases grains of olivine. In this specimen the hornblende has been wholly absorbed; many pseudomorphs, however, of the crystals are left as patches of densely crowded magnetite

[1] Since writing the above description, I find that Mr. Teall has recently examined and described some specimens of basalt from Possession Island brought back by Captain Jenssen. Sections kindly shown to me by Mr. Teall present precisely the same characters as those described above.

grains, sometimes lenticular in shape, but occasionally presenting crystal outlines. Some of these patches are surrounded by a narrow border of purplish augite; others have clearer spaces in the centre filled with an aggregate of magnetite, purple augite, and felspar, more coarsely crystallised than the groundmass. Consideration of this specimen and of the preceding suggests that it was only in the quickly cooled surface of the lava that the hornblende crystals have been preserved. In the more slowly cooled material they have been almost wholly absorbed by the groundmass.

The groundmass consists of magnetite and felspar laths, with olivine, a little augite, and traces of glass. The felspar and olivine have the same characters as in the preceding rock: the granular augite is in very small amount. The magnetite occurs in two generations, in grains and octahedra (in which form it is enclosed in the augite phenocrysts), and in minute rod-like skeleton growths fringing and often set at right angles to the sides of the felspar laths, and certainly one of the last minerals to separate. The specific gravity of this rock was 2·82.

These basalts are very similar to the hornblende-basalts in the Rhön-gebirge, *e.g.* to the rock from Kirschberg, near Rasdorf, a specimen of which is in the Museum collection.

Another rolled pebble of black compact basalt is similar to the preceding, but is finer grained, and contains no porphyritic crystals. It consists of a fine grained felt of felspar laths, a little granular augite and olivine, with much magnetite in grains and some purplish-brown glass. It is worthy of note that in this specimen containing glass there are no magnetite skeletons.

In the section are a few grains of quartz; these have probably been derived from the granite to be later described; they are surrounded by zones of pale greenish radiating needles, from their high angle of extinction (about 30°) referred to augite.

Adhering to this specimen was a piece of brown tuff containing, besides fragments of glassy basalt, also broken crystals of basaltic hornblende similar to that described above, and rounded grains of quartz.

Palagonite-Tuff.

A section of a pale brown palagonite-tuff, similar to that adhering to the basalt, showed fragments of highly vesicular basalt-glass, and of less glassy basalts similar to those described above, cemented by yellow palagonite and zeolites. Crystals of basaltic hornblende, quartz and felspar, and a fragment of the phonolite described below, also occurred.

The felspar was tabular, showing twin striations with symmetrical extinction of 6° (oligoclase). The quartz showed liquid inclusions with spontaneously moving bubbles, thus suggesting its deep-seated origin.

The very vesicular basalt-glass is light brown and fairly transparent. It contains comparatively large grains and crystals of magnetite, and lath-shaped felspars marking flow structure, with minute microliths of olivine, hornblende, and a little augite. Beside the lath-shaped crystals of felspar there are also extremely thin rhombic plates of a more acid felspar. The hornblende occurs in long prismatic microliths and also in perfectly rounded blebs. It is strongly pleochroic, and similar to that described above. The olivine occurs sparingly in minute rhombic sections, but mainly in forked skeleton crystals as figured in Rosenbusch's *Mikrosk. Physiog.* 2nd Ed. Vol. I. Plate II. Fig. 4. Often two of these skeleton crystals are crossed apparently in twin position. The augite in very minute long prismatic microliths, showing terminal faces and giving wide angles of extinction, is very sparingly present.

Some of the basalt fragments in the tuff were less glassy than the above. In these the magnetite had separated to a large extent in skeleton crystals: they also contained hornblende crystals and small rhombic sections of olivine.

Phonolite.

The specimen of phonolite from Possession Island is a compact brownish grey somewhat altered rock, showing to the naked eye only a few small porphyritic crystals of glassy felspar. Under the microscope it is seen to consist of a felt of felspar laths, a little magnetite, and ægyrine-augite uniformly distributed in small prismatic crystals and occasionally in granular aggregates. The maximum extinction in these prismatic crystals of ægyrine-augite was about 34°. An octagonal section showed a nearly rectangular cleavage, and in convergent light the emergence of an optic axis just off the field. The pleochroism in this section was from green to reddish-brown, while in a prismatic section it was green to brownish-green. These characters correspond to the ægyrine-augite of Rosenbusch, with axis a inclined 34° to *c*, and with pleochroism a=green, b=brownish-green, c=reddish-brown. The felspar laths give almost straight extinction; they show a general tendency to point in one direction, but sometimes form radiating groups. The structure is trachytic.

The presence of nepheline was only doubtfully indicated by a few rectangular sections with weak double refraction. A few minute grains of a strongly doubly refractive mineral are doubtfully referred to sphene.

Granite.

The fragments of muscovite-granite were probably derived from the tuff, since one of them had a little of the tuff adhering to one side of it. The granite consists of a medium-grained aggregate of quartz, microcline, orthoclase, oligoclase, and muscovite, with small black prismatic crystals of tourmaline. The quartz is the most plentiful constituent. It contains dusty inclusions, and also very minute liquid inclusions with spontaneously moving bubbles, as in the fragment included in the basalt. The felspars are quite fresh. The microcline is the most abundant. It appears to have been, as is generally the case in granites, the last mineral to consolidate, for it moulds the quartz which is generally rounded in contact with it, and it includes rounded grains both of quartz and oligoclase: a rounded quartz grain in contact with microcline appears to have been corroded and penetrated by the latter. The cross-hatching of the microcline is well shown between crossed nicols. The oligoclase shows very fine twin laminæ, and gives low angles of extinction. The muscovite occurs in large ragged plates. The tourmaline is in prismatic crystals enclosed in the quartz and microcline. In the quartz it occurs in all gradations of size down to the finest hairs. The pleochroism is from deep indigo-blue to pale lavender, but the larger crystals have a border with different pleochroism from brownish-yellow to pale lavender.

Some of the fragments of muscovite-granite contained, in addition to the tourmaline, small pink garnets.

(4.) *Franklin Island.*

After leaving Possession Island, the expedition proceeded along the coast of Victoria Land, with its "magnificent chain of mountains" stretching away to the southward, as described in Ross's account. A lofty peak named Mount Melbourne was, according to McCormick, evidently a volcanic cone, with a perfectly shaped crater.

When in about lat. 73° S. the dredge brought up a "block of grey granite, composed of large crystals of quartz, mica and felspar, with apparently a clean and recent fracture, as if lately broken off from the main rock." This specimen was not found in the collection.

Franklin Island, the most southerly land on which a landing was effected, is situated in lat. 76° 8′ S. and long. 168° 12′ E. and is about 12 miles long and 6 miles broad. According to Ross, it is composed wholly of igneous rocks. Not a trace of vegetation was found upon it.

The specimens collected are all of *basalt* of the same type.

It is a black compact rock, not markedly porphyritic. Under the microscope small idiomorphic olivines and magnetite are seen very

uniformly distributed in a base of purplish to colourless augite in minute prismatic microliths, and felspar in laths and in plates. In the base in subordinate amount were patches of a weakly doubly refractive mineral, which appeared to form a paste for the lath-shaped felspars. This is doubtfully referred to nepheline, since it gave straight extinction along straight edges, and in one section, which remained dark between crossed nicols, a faintly distinguishable uniaxial figure.

The olivine is in sharp hexagonal sections, generally bordered with a deep orange-red alteration product.

The augite of the groundmass is in minute prisms idiomorphic with respect to the felspar.

The felspar laths give nearly straight extinction, and are probably to be referred to andesine.

The specific gravity of the rock was 2·87.

The result of a quantitative chemical analysis is as follows :—

SiO_2	...	=	45·61
TiO_2	...	=	3·48
SnO_2	...	=	trace
Al_2O_3	...	=	15·70
Fe_2O_3	...	=	6·17
FeO	...	=	7·29
MnO	...	=	trace
CaO	...	=	6·34
MgO	...	=	4·84
K_2O	...	=	2·67
Na_2O	...	=	5·06
Loss on ignition		=	2·34
			99·50

In this analysis 1·4817 gram was used for the determination of silica, &c., by fusion with sodium and potassium carbonate; 0·6968 gram for the determination of ferrous oxide by decomposing with hydrofluoric and sulphuric acids in an atmosphere of carbonic acid, and titrating with permanganate of potash; and 0·6401 gram for the determination of alkalies by Lawrence Smith's method.

Proceeding southward from Franklin Island, the Expedition discovered in about lat. 77° 31′ S. and long. 167° 1′ E. the active volcano discharging "flame and smoke," Mount Erebus, 12,367 feet in height, with the neighbouring extinct crater, Mount Terror, 10,884 feet high.

From the cape at the foot of these mountains extended to the eastward

that vast barrier of ice forming a continuous perpendicular wall, varying in height from 100 to 200 feet, which prevented all further progress southward. Along the face of this great wall of ice the Expedition sailed for about 300 miles without finding any inlet. According to Sir John Murray (*Proc. Roy. Soc.* LXII. No. 387, pp. 424-51) this great ice barrier "was evidently the sea-front of a great creeping glacier or ice-cap, just then in the condition to give birth to the table-shaped icebergs, miles in length, which have been described by every Antarctic voyager." The proximity of this ice-barrier to extended land surfaces thus suggested receives some sort of confirmation from the fact mentioned by Ross, that in soundings made off the barrier in 410 fathoms in about lat. 77° 47′ S. and long. 176° 43′ E. the leads sank fully two feet into a soft green mud; for during the voyage of the *Challenger* the dredging up of blue and green muds, derived from the degradation of crystalline rocks, was always a sure indication of the approach to land. Unfortunately no specimen of this green mud appears to have been preserved.

II. Second Voyage Southward.

On the second journey southward the expedition was beset for long periods in the pack ice, and no landing was effected anywhere.

The only rock specimens collected were in the form of pebbles found in the stomachs of seals and penguins.

These specimens are of interest as throwing some light upon the question as to the existence and character of that great Antarctic continent which is supposed to encircle the South Pole, for in all probability they were obtained by the seals and penguins from floating ice which at one time helped to form the glaciers of that southern land. The fact that blocks of gneiss and granite,[1] which must have been deposited from icebergs, were dredged up by the *Challenger* Expedition in southern latitudes, is brought forward as evidence of the existence of this continent. The evidence afforded by these pebbles is of a similar character, as will be seen from the following descriptions. The effects of dynamic metamorphism observed in many of them also indicate that the region from which they came has been the seat of great mechanical disturbances. Amongst the pebbles are examples of the following kinds of rock :—

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[1] In the Museum is exhibited a large block of gneiss dredged from diatom-ooze, in lat. 53° 55′ S. and long. 108° 35′ E., about 600 miles N.E. of Wilkes Termination Land. According to Sir John Murray (*Proc. Roy. Soc.* 1898, LXII. pp. 424—51), the dredgings of the *Challenger* brought up, besides gneiss and granite, also mica-schists, diorites, quartzites, sandstones, limestones and shales.

In other specimens the interstitial augite is more indistinct and more confusedly intergrown with magnetite, so that it can often only be recognised by the colours between crossed nicols.

In yet other specimens the magnetite skeletons are very minute and feathery, and no augite can be distinguished. In these specimens the same orientation as previously described of the magnetite rods at right angles to the olivine and to the length of the felspar laths was noted.

Then there are specimens in which the interstices between the felspar laths are filled with a deep brown glass, with only slight separation of magnetite.

Finally, on the surface of the lava-flow is a clear light-brown glass, with phenocrysts of olivine and felspar and no separation of magnetite whatever.

Such a concentration of iron in the mother-liquor of basic magmas as indicated by the above observations has been recently noted and emphasised by Teall in the case of basalts from Franz Josef Land.[1]

The olivine in all the above specimens is of the same character. It is generally perfectly clear and fresh. The large phenocrysts show mostly sharply-defined hexagonal sections, but sometimes occur in groups of broken fragments separated by the magma. Occasionally they are in elongated prismatic crystals, as described by Dana in the case of Hawaiian basalts.[2] In many cases they have been corroded and penetrated by the magma. They contain inclusions of brown sub-translucent octahedra of picotite (?) and of glass (showing sometimes separation of augite and magnetite).

The olivine of the groundmass is in large amount and shows rhombic sections with central inclusions of glass. It sometimes occurs included in the felspars, but is often in irregular patches interpenetrated by the felspar laths, as if of later consolidation.

The felspar in these specimens is mainly a basic labradorite with twin striations showing a maximum symmetrical extinction of about 32°. Besides these sharply defined lath-shaped felspars, in some specimens there are a few larger and broader felspars of a more acid type having zonal extinction. These are often cracked and bent, and show rounded indistinct outlines as if partially absorbed. One section, showing no twin laminæ, exhibited in convergent light a positive biaxial figure with a very small optic axial angle.

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[1] *Quart. Journ. Geol. Soc.* LIII, (1897), p. 487.

[2] *Am. Journ. Sci.* XXXVII. (1889). p. 441.

ragged grains, often aggregated into groups, but generally fairly uniformly distributed in a paste of water-clear felspar, which is partly in laths with indistinct outline and partly in plates.

The felspar has the characters attributed to secondary felspar. It is water-clear, and for the most part shows no twin striations, so that it is often only to be distinguished from quartz by observation in convergent light. The lath-shaped crystals have nearly straight extinction, and are probably andesine. One or two larger sections showing twin striations are more basic, and are probably some of the original labradorite of the dolerite. One section, giving symmetrical extinction of about 28°, had a border of water-clear felspar, giving straight extinction. The hornblende is similar to that of the Scourie dyke, but does not occur in such large plates. The pleochroism was a=pale yellow, b=dull yellowish-green, c=dull bluish-green.

Magnetite is present in comparatively large grains, but in small amount. Calcite and epidote occur in minute veins.

Finally, there are one or two irregular patches of a yellow mineral, which from its very strong refraction and double refraction was referred to sphene. This was confirmed by observation of one section, which showed in convergent light a positive biaxial figure with a small optic axial angle and with strong dispersion $\rho > v$.

In the specimen showing the contact of epidiorite and cataclastic granite, this granular sphene with a little hornblende is seen to occur near the contact both in the granite and in the epidiorite. As in the case of the Scourie-dyke rock, the sphene has probably resulted from the alteration of the titaniferous iron-ore of the original dolerite.

Other specimens showed less advanced stages of alteration, and except for the change of augite to hornblende were nearer to ordinary dolerites. One example consisted of small lath-shaped felspars showing flow structure, with large irregular ragged patches of a fibrous hornblende showing pleochroism a=very pale yellow, b=pale dirty greenish-brown, c=dirty bluish-green. Biotite is present in small amount, and magnetite in comparatively large grains.

Another specimen was coarser-grained, and showed large prismatic felspars, a little quartz and large ragged patches of biotite and hornblende. The hornblende had obviously resulted from the alteration of augite, since the latter mineral occurs as the nucleus of one or two of the hornblende patches.

Dolerites.

The dolerites found among the pebbles were somewhat similar in

character to the unaltered dolerite of the Scourie dyke, and might well have been the original rocks from which some of the above epidiorites were derived.

One example consists of a coarse-grained aggregate of broad prismatic crystals of labradorite (symmetrical extinction of about 25°) and pale purple augite in irregular plates, penetrated by the felspar, and thus presenting a sub-ophitic structure. Iron-ore, probably titaniferous, occurs in irregular plates. Yellow fibrous hornblende is present in small amount, probably resulting from the alteration of the augite. In the section is a small patch of kaolinised felspar (in tabular crystals and of more acid type) which appears to be a foreign inclusion, probably from a granite.

Another specimen is of similar character to the preceding, but of much coarser grain. It consists of large interlacing prismatic crystals of labradorite with broad ophitic patches of greenish-brown fibrous hornblende, containing in many cases a nucleus of the original purple augite. Iron ore was present as in the preceding rock.

Basalts.

Amongst the basalts no specimen precisely similar to any of those described in the first section of this paper was found. This should not be surprising if the supposition is well grounded that the pebbles were mainly derived from a great Antarctic continent further southward. One specimen, however, bore some resemblance to basalts from Cockburn Island, off Louis Philippe Land, to be described in the next section.

In this rock the only porphyritic constituent is perfectly clear fresh olivine in large crystals, generally with fairly sharp hexagonal outlines, but sometimes invaded by the base. They contain a few inclusions of magnetite, picotite (?), and blebs of glass. The groundmass consists of very minute microliths and forked skeleton crystals of felspar in a deep brown glass crowded with minute skeleton growths of magnetite. Augite in small amount is only to be distinguished between the felspars and intergrown with magnetite by the polarisation colours. As in the Cockburn basalts (see p. 87), this mineral and the magnetite appear to have been the last to separate. In the groundmass were also a few small grains of olivine; sometimes two such grains would be attached on each side of a felspar lath, as though of later date. Scattered through the base were numerous minute round colourless isotropic patches, looking like microscopic vesicles filled with an isotropic zeolite.

Another basalt, medium-grained approaching to dolerite, shows microporphyritic lath-shaped felspars and altered olivine in a base of smaller

felspar laths, altered olivine and purple augite minutely ophitic with respect to the felspar. Magnetite is present in comparatively large crystals and rods. The larger felspars are of labradorite with a symmetrical extinction angle about twin laminæ of 29°, and are of the same general character as the smaller ones of the base. Symmetrical extinction angles, however, in the latter were generally lower (19°). The olivine is in large amount, but is all altered to a yellowish-brown fibrous strongly doubly refractive hornblendic (?) mineral.

Another basalt specimen is of more acid type. It consists of a few porphyritic labradorites (symmetrical extinction of about 21°) in prismatic crystals much corroded and partially re-absorbed by the base, with a few small purplish augites, in a dense base containing much granular magnetite, colourless augite in grains and minute prisms, and lath-shaped felspars giving straight extinction (probably andesine).

Rhyolites.

One specimen appears to be a rhyolitic breccia. It consists of much altered fragments of microfelsitic material, probably a devitrified glass, showing flow structure, and containing corroded quartz grains penetrated by the magma.

Another much altered specimen shows under the microscope alternating parts of clear and cloudy cryptocrystalline material. The cloudy material appears to consist of pseudo-spherulites. Between crossed nicols the section resolves itself into an aggregate of round patches of differently orientated material, but no definite black crosses are seen. One or two corroded quartz grains occur as the nuclei of some of the circular patches. Some of the Hungarian rhyolites present a similar structure, *e.g.* the rock from Abanj Szanto, Tokaj.

Micaceous Quartz-Grits (micaceous schists).

One specimen shows sub-angular quartz grains with brown interstitial matter containing smaller quartz grains and ill-defined biotite. The quartz contains liquid inclusions with spontaneously moving bubbles. In the arrangement of the quartz grains there is some approach to schistose structure.

Another specimen consists of clear quartz grains connected by a network of apparently more recent quartz, with lines of reddish-brown pleochroic biotite giving foliated structure.

The microscopic characters of these specimens suggest the idea that they may be quartz-grits metamorphosed by granite-contact into micaceous schists.

III. Third Voyage Southward.

In the course of the third voyage into Antarctic regions, the only landing effected was on Cockburn Island, in lat. 64° 12′ S. and long. 56° 49′ W., off Louis Philippe Land, south of the South Shetlands.

About this particular part of the Antarctic regions, according to Sir Archibald Geikie,[1] within recent years sealing vessels have brought home scraps of information. Thus from the islets of Graham Land to the south of the South Shetlands fragments of granite, volcanic rocks and fossiliferous limestone have been collected. From Dundee Island, close to Joinville Island which forms the north-eastern termination of Graham Land, come specimens of granite[2] and a piece of radiolarian chert very similar to cherts in the Lower Silurian formations of the United Kingdom. From Seymour Island, in the same district, Captain Larsen brought back pieces of fossil coniferous wood, and also fossil shells similar to species in lower Tertiary beds of Patagonia.

The specimens from Cockburn Island collected by the Ross Expedition include *basalt*, *palagonite-tuff*, *granite*, and *calcareous glauconitic sandstone*.

Basalts.

The basalt specimens are of a black compact, generally non-vesicular rock, showing to the naked eye porphyritic perfectly fresh yellow olivines, while with the lens small striated lath-shaped felspars can be detected. One large specimen shows the ropy surface of the lava consisting to the depth of more than half an inch of basalt-glass. All the specimens probably came from the same eruptive mass, but they show under the microscope interesting gradations of structure from a clear glass to a perfectly crystalline rock.

The most holocrystalline rock of this series consists of a medium-grained aggregate of olivine, felspar laths, deep purple augite and magnetite. The olivines occur in two generations, in large phenocrysts and in smaller crystals between the felspar laths. The augite is in small irregular ophitic patches penetrated by the felspars.

In other specimens the structure is more distinctly porphyritic: phenocrysts of clear unaltered olivine occur in a medium-grained base of lath-shaped felspars, the interstices between which are filled with augite intergrown with skeleton crystals of magnetite. The colour of the augite varies from deep purple to almost colourless.

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[1] *Proc. Roy. Soc.* 1898, LXII, pp. 424–51, and *Proc. Roy. Soc. Edinb.* 1898, XXII. p. 66.

[2] Described by Teall (*Proc. Roy. Soc. Edinb.* XXII. (1898), p. 58).

From a seal caught Dec. 1841, in about lat. 63° 4′ S. and long. 151° 2′ W.: *granite* and *epidiorite*.

From a large penguin caught Dec. 22, 1841, in lat. 65° S. and long. 154° W.: *granite*, *basalt* and *rhyolitic breccia*.

From a seal caught Jan. 1842, in about lat. 66° S. and long. 156° W.: *granite*, *epidiorite*, *dolerite*, *basalt* and *rhyolite*.

From a penguin caught Jan. 28th, 1842, in about lat. 67° S. and long. 156° W.: *micaceous quartz-grit* (*micaceous schists*).

Granites.

The granites are pink and grey rocks, consisting of quartz, orthoclase, oligoclase, and a little biotite and hornblende. Most of them show to a greater or less extent the effects attributed to dynamic metamorphism. The quartz almost invariably shows marked undulose extinction, and each grain between crossed nicols resolves itself into an aggregate of irregular differently orientated smaller grains. It contains strings of dusty inclusions and fluid-pores with spontaneously moving bubbles.

The oligoclase shows thin twin laminæ which are often bent. In some specimens it is altered with development of much clear yellow epidote.

The biotite is generally only present in small amount: in some specimens it has been converted into pleochroic chlorite.

The orthoclase in some of the pebbles appears to have been largely replaced by microcline. The cross-hatching, however, is not well marked, and it is possible that we have here an example of microcline structure developed in orthoclase as the result of mechanical strain.

In some of the granites the effects of earth stresses are even more marked, and advanced stages of cataclastic structure precisely similar to those figured in Rosenbusch's *Mikros. Physiog.* Vol. II. Plate I. Figs. 3 and 4, are exhibited.

One pebble showed the contact of such a cataclastic granite with an epidiorite which is probably a dolerite metamorphosed by the same dynamic effects which have affected the granite.

Epidiorites.

The epidiorites are dark green rocks, presenting generally very similar characters to those of the well-known rock of the Scourie dyke described by Teall.[1] They are probably metamorphosed dykes of dolerite in granite, for several of the pebbles show the contact of epidiorite and granite. Under the microscope one specimen shows green hornblende in small

[1] *British Petrography*, Pl. XIX, XX, pp. 197–200.

Magnetite occurs generally in skeleton growths as one of the last minerals to separate: only in the holocrystalline specimen, in which the augite is in ophitic patches, does it occur in large grains, and in this case these grains appear to be generally wedged in between the felspar laths.

Basalt Glass.

Sections from the large specimen with glassy surface showed that between the base of the specimen (about 7 in. from the surface) and about 1 in. from the surface the rock is fairly uniform in character, and consists of phenocrysts of olivine in a groundmass of smaller olivines and interlacing felspar laths with the interstices filled with glass so dense from separation of magnetite as to be opaque. As the surface is approached the amount of this dense glass increases. Then follows a zone in which the magnetite has separated in cloudy patches or cumulites, and also in thick seams round the olivine and felspar phenocrysts, leaving in the interspaces a clear yellow glass. To this succeeds a zone, in which there are no cumulites of magnetite, but the phenocrysts are still slightly coated, and the glass is darker and less transparent than in the preceding zone. Finally, on the surface is a clear light brown glass, in which occur olivines and felspars, but no magnetite whatever. The large porphyritic olivines in this glass are often corroded into fantastic shapes. Round one crystal the glass shows perlitic cracks. The smaller olivines are very sharply defined, and being so minute, show in the section actual faces of pinacoids and domes. Olivine also occurs in the form of forked skeleton crystals.

The felspar is mostly in sharply defined laths of labradorite, generally with ragged ends, but sometimes showing terminal c (001) and x ($\bar{1}01$) faces. It occurs also in extremely thin rhombic plates, showing zonal extinction and often enclosing olivine. These plates show traces of the faces c, x, and also of y ($\bar{2}01$). Supposing they are parallel to b (010) the extinction with respect to the trace of c varied from 4° in the centre to 16° on the edge. No augite microliths could be detected.

Some of the glassy basalts of the Rhöngebirge, *e.g.* the rocks from Schwarzenfels and Sterbfritz, present somewhat similar characters.

The specific gravity of the basalt about 7 in. from the glassy surface is 2·89 : that of the glass on the surface 2·79.

The results of quantitative chemical analyses of this basalt and of the glass are as follows :—

Basalt (7in. from surface).				Basalt-Glass.
SiO_2	= 48·97	...	...	50·22
TiO_2	= 1·62	...	...	1·95
Al_2O_3	= 16·12	...	...	16·20
Fe_2O_3	= 1·90	...	...	3·13
FeO	= 9·63	...	...	8·07
MnO	= trace	...	...	trace
CaO	= 8·73	...	...	8·57
MgO	= 7·64	...	...	7·54
K_2O	= 1·21	...	...	1·38
Na_2O	= 2·99	...	...	3·36
Loss on ignition (mainly CO_2)	1·39	...	...	0·22
	100·20			100·64

In these analyses the same methods were used as in the case of the basalt from Franklin Island (p. 80). The weights taken of basalt and glass were respectively—1·4479 gram and 1·4090 gram for the determination of silica, etc.; 0·8525 gram and 0·6968 gram for the ferrous oxide; and 0·6150 gram and 0·6401 gram for the alkalies. The fairly close agreement between the analyses precludes the idea that anything in the way of differentiation has taken place within a depth of 7 inches. The slight differences in the percentages of silica, loss on ignition (carbonic acid), and ferric oxide, may be accounted for by the fact that in the basalt, as noticed in many specimens, there has been some slight development of chalybite at the expense of olivine, and that the glass has suffered a little surface oxidation.

Palagonite-Tuff.

A palagonite-tuff from an iceberg off Cockburn Island consists of fragments of precisely similar glass to that described above altering to orange-yellow palagonite, and cemented by chalybite, calcite, and zeolites. In character it corresponds almost exactly to a palagonite-tuff from Kerguelen Land, described by Renard.[1]

Granites.

Of the two specimens of granitic rocks from Cockburn Island, one with pink felspars, described on the label as a boulder, shows under the microscope very beautiful micropegmatitic structure of quartz and orthoclase. Oligoclase is also present, and altered biotite with green hornblende. The felspars are altered with development of epidote.

[1] *Challenger Reports.* VII. Petrography of Oceanic Islands, p. 116.

The other specimen, a chip of grey granite with sharp edges, is fresher, and shows no granophyric structure. It consists of quartz, orthoclase, oligoclase and microcline, with biotite in large ragged plates, and hornblende. The quartz is idiomorphic (in parts of the section giving hexagonal outlines) with respect to the microcline. The hornblende in prismatic sections is pleochroic from dull green to yellowish-brown, and shows polysynthetic twinning on $a(100)$.

Calcareous glauconitic Sandstone.

This rock consists of sub-angular grains of quartz and a little orthoclase and oligoclase (symmetrical extinction of twin laminæ about 5°), with grains of iron ore, zircon, pink garnet and green glauconite, all cemented by calcite. The quartz shows liquid inclusions with bubbles, and also hair-like inclusions such as occur in the quartz of many granitic rocks. The grains of iron-ore, zircon and garnet generally occur in strings; with them are a few deep-red pleochroic needles of a doubly-refracting mineral, possibly rutile.

A specimen obtained from an iceberg off Cockburn Island is a very fine-grained grey loosely coherent *sandstone*, showing to the naked eye here and there minute scales of glittering white mica. Under the microscope it is seen to consist of minute sub-angular grains of quartz and felspar and a little glauconite, with brown dusty interstitial matter.

A light greenish-grey compact *quartzite* from a piece of ice off Cockburn Island showed under the microscope a minutely crystalline aggregate of sub-angular quartz grains with indistinct flecks of a pale green hornblendic mineral giving the colour to the rock, a few rounded granules of zircon and a little felspar and mica.

Pebbles from a young penguin caught off Louis Philippe Land on December 31st, 1842, include specimens of *basalt, perlitic and spherulitic rhyolite, quartz-grit, slate* and *gneiss.*

The *basalts* present characters very similar to those of Cockburn Island, one specimen corresponding to the holocrystalline anamesitic type with ophitic augite, and the others to the more glassy varieties.

Of the *rhyolites* one specimen of a pale green colour showed to the naked eye phenocrysts of quartz and milk-white felspar. Under the microscope the quartz is seen to be rounded and penetrated by the magma: the felspar in large prismatic crystals is kaolinised and nearly opaque; some sections without twin laminæ show the parallel parting characteristic of sanidine, while others with fine twin laminæ are probably of oligoclase. The microfelsitic base consists of alternating

bands of light brown cloudy material showing flow-structure, and of clearer material exhibiting perlitic structure made evident by means of a pale green chloritic mineral.

Another milk-white rhyolite showing phenocrysts of quartz and felspar is seen under the microscope to consist of a dense cloudy microfelsitic base, showing in parts spherulitic structure with black crosses, in which are distributed large prismatic crystals of sanidine and smaller and more fragmentary and corroded crystals of oligoclase and quartz.

These rhyolitic rocks, like those collected during the second voyage, in both their macroscopic and microscopic characters are very similar to some of the Hungarian rhyolites.

The specimen of *quartz-grit* consists of angular grains of quartz (containing liquid inclusions) and felspar, with a little altered ferro-magnesian mineral.

Pebbles of dark-grey banded *slate* showed schistose structure with wavy dark bands encircling minute lenticular eyes of quartz-mosaic and calcite.

The specimen of *gneiss* shows quartz and orthoclase with foliation well marked by bands of pleochroic biotite. Oligoclase occurs in small amount, and a few rounded grains of zircon. Pœcilitic rounded quartz grains are present in the felspars.

In conclusion is appended the following list of the various kinds of rocks from Antarctic regions found in the Ross collection: –

From Auckland Islands (lat. 50°32′ S.; long. 166°12′ E.): *basalt.*

From Campbell Island (lat. 52°33′ S.; long. 169°8′ E.): *basalt, silicified globigerinal limestone, chert.*

From Possession Island (lat. 71°56′ S.; long. 171°7′ E.): *basalt, palagonite-tuff, phonolite, muscovite-granite.*

From Franklin Island (lat. 76°8′ S.; long. 168°12′ E.): *basalt (nepheline-basanite?).*

From Cockburn Island (lat. 64°12′ S.; long. 56°49′ W.): *basalt, palagonite-tuff, granite, calcareous glauconitic sandstone.*

From seals and penguins caught between lat. 63° S.; long. 151° W. and lat. 67° S.; long. 156° W.: *granite, epidiorite, dolerite, basalt, rhyolite, micaceous quartz-grit.*

From penguin caught off Louis Philippe Land in about lat. 64° S. long. 54° W.: *basalt, perlitic and spherulitic rhyolite, quartz-grit, slate, and gneiss.*

Riebeckite in Trachytic Rocks from Abyssinia.

By G. T. Prior, M.A., F.G.S.,
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[Read Nov. 15th, 1898.]

IT is now ten years since Sauer[1] first described under the name of riebeckite a new species of blue hornblende in the granite of Socotra.

Since that time its occurrence in the British Isles has been noted in the "felsite" of Mynydd Mawr,[2] N. Wales; in the "microgranite" of Ailsa Craig,[3] Firth of Clyde; in glacial deposits from the Isle of Man; Moel Tryfaen,[4] N. Wales; Greystones, Co. Wicklow[5]; and Greenore, Carlingford[6]; in granophyre from Meall Dearg,[7] Skye; and in felsite from Middle Eildon,[8] Roxburghshire.

On the Continent it has been recorded in "granulite" from Corsica,[9] in the trachyte of Berkum,[10] Rhine, and in a minette from Wackenbach, Vosges.[11]

In America riebeckite and blue hornblendes allied to it have been described from Colorado[12] (El Paso Co. and Silver Cliff), Texas[13] (Paisano Pass), Michigan (Lake Superior region),[14] and California (Berkeley).[15]

In India it has been noted in a granite from Southern Sikkim.[16]

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[1] "Ueber Riebeckite, ein neues Glied der Hornblendegruppe." *Zeits. deutsch. geol. Ges.* XL. (1888), p. 138.

[2] Bonney, *Min. Mag.* VIII. (1888), pp. 103, 169; Harker, *Geol. Mag.* 1888, p. 455.

[3] Teall, *Min. Mag.* IX. (1891), p. 219; Heddle, *Trans. Edin. Geol. Soc.* VII. (1897), p. 265.

[4] Cole, *Min. Mag.* IX. (1891), p. 222.

[5] Sollas, *Proc. Roy. Irish Acad.* III. (1895), p. 516.

[6] Cole, *Nature*, XLVII. p. 464.

[7] Teall, *Quart. Journ. Geol. Soc.* 1894, p. 219.

[8] Barron, *Geol. Mag.* 1896, p. 371.

[9] Le Verrier, *Compt. Rend.* CIX. (1889), p. 38.

[10] Rosenbusch, *Mikr. Phys.* II. p. 770, 1896.

[11] Rosenbusch, *ibid.* p. 510, 1895.

[12] Lacroix, *Compt. Rend.* CIX. (1889), p. 39; König, *Zeits. Kryst.* 1, p. 430; Cross, *Am. Journ. Sci.* XXXIX. (1890), 359.

[13] Osann, *Geol. Survey of Texas*, 4. *Annual Report*, 1893.

[14] Lane, *Am. Journ. Sci.* XLII. (1891), 508.

[15] C. Palache, *Bull. Dept. Geol. Univ. California* 1 (1894), 185.

[16] Holland, *Records Geol. Survey India*, XXV. pt. 3, 1892.

The object of this note is to place on record a new occurrence of riebeckite in trachytic rocks from Abyssinia.

The specimens in the British Museum in which the riebeckite was found form part of a collection of rocks made by Mr. W. T. Blanford when acting as geologist to the Abyssinian Expedition of 1868 under Sir Robert Napier.

In his book, *Observations on the Geology and Zoology of Abyssinia* (London: Macmillan & Co. 1870), Blanford describes the geological features of the country traversed by the Expedition from Annesley Bay on the Red Sea to Magdala.

The following details as to the mode of occurrence of the trachytic rocks are drawn from that work.

The fundamental rocks of the province of Tigre "and probably of all Abyssinia" are metamorphics. On the route to Magdala almost all hills exceeding 8,000 ft. in height above the sea were found to consist of bedded traps (trachytes and basalts). Between the metamorphics and the traps occur a series of sandstones and limestones, the latter alone fossiliferous and of Jurassic age.

The volcanic rocks were first met with at Senafé, which lies in a plain with hills on both sides generally composed of basalt and trachyte, the latter predominating. The highest point, Akúb Teriki (or Arabi Teliki), 9,000 feet high, a most conspicuous object to the north of Senafé, consists near its base of basalt and trachyte, with a flat top composed of a coarse "trachyte" resembling sandstone. It was not clear whether this mass is intrusive or whether it fills a hollow in the metamorphics. About 8 miles W. by S. of Senafé is the trachytic hill of Kishyat, the north face of which is precipitous and consists of "magnificent vertical columns extending the whole height of the cliff, upwards of 300 feet, without a single break."

Similar hills of "trachyte" are dotted over the country to the south as far as Fokada, a distance of nearly 30 miles. These were regarded by Blanford as probably the remains of the same great lava flow. The columnar trachyte of a hill near Fokada closely resembles that of Kishyat; here it rests on basalt, which again overlies unconformably the Adigrat sandstone. These trachytic hills are described as rounded hummocks of very peculiar shape, suggestive rather of granitic than of trachytic masses. The geological age of the trachyte is uncertain, as no other formation rests upon it.

The specimens containing riebeckite which form the subject of this note come from Akúb Teriki, Kishyat, and Fokada.

The trachyte from the hill near Fokada is a fine-grained pale lavender-coloured rock, showing to the naked eye a few porphyritic crystals of glassy felspar. Under the microscope it exhibits trachytic structure, and is seen to consist of a felt of small lath-shaped felspars with a little quartz, uniformly distributed in which occurs in moss-like sub-ophitic patches the riebeckite, presenting much the same appearance as it does in the Mynydd Mawr rock. In this groundmass porphyritic crystals of felspar (probably anorthoclase), mostly in Carlsbad twins, occur sparingly, either singly or in groups. In this respect, as well as in the character of the groundmass, the rock bears a more striking resemblance to the well-known trachyte of the Hohenberg at Berkum, near Remagen, on the Rhine, than to the Mynydd Mawr rock.

This Berkum trachyte is referred by Rosenbusch to a special arfvedsonite (riebeckite) type of trachyte. Examination of a specimen in the Museum collection shows that the blue hornblende in moss-like patches which it contains presents precisely the same pleochroism (deep indigo-blue to pale yellowish-brown) as that in the Mynydd Mawr rock, and that the a (not the c) axis of the indicatrix is the one nearly coincident with the vertical crystallographic axis c.

In the Abyssinian rock the blue hornblende shows similar characters. Prismatic sections compensate with the quartz wedge along their length, and give low angles of extinction (in one section about 5°). Such sections show pleochroism from a dirty pale yellowish-brown to deep indigo-blue (almost black). In a section showing the prismatic cleavage (inclined at an angle of about 120°) the pleochroism was from deep blue to pale yellowish-brown. For the three axes of the indicatrix we have therefore—

a (nearly parallel to c)=dark indigo-blue,
b (bisecting the acute angle of the cleavage)=deep blue,
c=pale yellowish-brown.

This is precisely similar to the pleochroism in the rocks from Mynydd Mawr, Berkum, and Ailsa Craig, but differs slightly from that of the original riebeckite from Socotra, in which, according to Rosenbusch, c=green.

The section of the trachyte from Kishyat presents somewhat similar characters to that of the rock from Fokada, but is slightly coarser-grained and contains more quartz; in the specimen examined the moss-like riebeckite was to a large extent converted into a black alteration product.

A minute crystal fragment of riebeckite detached from a cavity in this rock has at my request been measured by my colleague, Mr. L. J.

Spencer. The fragment showed the following forms:—$m(100)$, four planes; $n(310)$, a single narrow plane, new for riebeckite; $c(001)$, $z(021)$, $a(100)$, one plane of each; $a\,m\,n$ were striated vertically, and c and z parallel to their intersections. The following measurements were made:—

	Measured (L.J.S.)	Calcd. for Riebeckite (Sollas).	Hornblende (Dana).
110 : 1$\bar{1}$0	54° and 56¼°	$m\,m$ 56°	$m\,m$ 55°49′
001 : 100	76°15′	$a\,c$ 76°10′	$a\,c$ 73°58½′
001 : 110	77°46′	$c\,m$ 77°50′	$c\,m$ 75°52½′
021 : 001	29°46′	$c\,z$ 29°36′	$c\,z$ (29°27′), not an observed form
021 : 110	65°5′	$z\,m$ 65°28½′	
021 : 100	77°39′	$a\,r$ 78°0′	
100 : 310	9°0′	$a\,n$ (10°3′), not an observed form	$a\,n$ 10°0¾′

The rock from Akúb Teriki is of a somewhat different type to those from Fokada and Kishyat. Instead of being rough and porous as they are, it is compact, with a peculiar scaly appearance, rather like some phonolites. The microscopic characters suggest that it may be an intrusive rock. The groundmass consists of a felt of lath-shaped felspars similar to that of the preceding rocks, but of much coarser grain. Large phenocrysts of glassy felspar (probably anorthoclase[1]) occur, in some of which are included rectangular sections of zircon, showing in convergent light a positive uniaxial figure. In this rock the riebeckite is accompanied by grass-green ægyrine, and in less amount by a brown hornblende, with which it often forms intergrowths similar to those described by Whitman Cross (*loc. cit.*) in the rock from Rosita Hills, Silver Cliff, Colorado. Irregular sections of hornblende (showing pleochroism from light brown to deep brownish-black) intergrown with ægyrine (compensating along the length of prismatic sections and showing pleochroism from grass-green to yellow), are fringed with tuffs of indigo-blue riebeckite.

This last rock, as well as the preceding, if intrusive, would fall into the "Paisanite" group of Rosenbusch, in which he includes the rocks from Mynydd Mawr and Ailsa Craig as well as the riebeckite rock described by Osann (*loc. cit.*) from Paisano Pass, Texas, which gives its name to the group.

[1] Extinction on $c(001)$ 0°—2°, on $b(010)$ 9°—12°; strong sodium flame.

Minerals from Swaziland: Niobates and titanates of the rare earths, chemically allied to Euxenite and Fergusonite; Cassiterite, Monazite, &c. The "Æschynite" from Hitterö.

By G. T. Prior, M.A., F.G.S.,

Assistant in the Mineral Department of the British Museum.

[Read April 5th, 1898.]

THE specimens described in this note were collected by Mr. Sydney Ryan, Managing Director of the Ryan Tin Mines, and were presented by him to the British Museum through Mr. John Ballot, who brought them to England.

They were found in the stanniferous gravels of the Embabaan district in Swaziland, S. Africa. Their probable source is the granite-gneiss which forms the base of the rock-series in that district.[1]

The species represented in Mr. Ryan's collection include euxenite- and fergusonite-like minerals, cassiterite, monazite, scheelite, corundum, magnetite and garnet.

Mineral chemically allied to Euxenite.

This mineral was found in loose tabular crystals, which are very rough and worn, and not suitable for accurate measurement. One crystal, in size about $3 \times 3 \times 1$ cm, shows the faces of two prisms, pinacoid (tabular faces) and basal plane. In habit it is very similar to the large crystals from Hitterö, described and figured by Brögger under the name of Æschynite in *Zeitschr. Kryst.* III. (1879), 481, figs. 18 and 19. Measurements with the contact-goniometer gave angles of about 118° and 54° respectively for the two prisms, and an angle of about 90° between base and pinacoid.

In physical characters it is also like the Hitterö mineral. The fracture is sub-conchoidal, with a brilliant vitreous to greasy lustre. The colour is brownish-black; that of the fine powder pale buff. In thin splinters the mineral is translucent, with a yellowish-brown colour, and is isotropic.

[1] The geology of the district is described by Prof. T. Rupert Jones in the *Geol. Mag.* for March, 1899.

The specific gravity is 4·996, as determined by hydrostatic weighing on a crystal weighing 28 grams.

Two quantitative analyses (I. and II.) were made on 1·2291 gram and 1·2788 gram respectively. The combined result is given under III.

	I.	II.	III.	Molecular Ratios.
Nb_2O_5	36·68	58·17	36·68	·1369
TiO_2	21·89		21·89	·2664
SiO_2	2·12		2·12	·0371
ThO_2		0·61	0·61	·0024
SnO_2	0·29		0·29	·0020
Y_2O_3, Er_2O_3	18·13	17·11	17·11 (molr. weight, 246)	·0696
Ce_2O_3, La_2O_3, Di_2O_3	3·22	4·32	4·32 (molr. weight, 310)	·0140
UO_3	3·16	2·14	2·14	·0074
UO_2		0·49	0·49	·0018
FeO	5·65	5·60	5·63	·0782
CaO	4·19	4·06	4·12	·0736
MnO		0·19	0·19	·0027
MgO	0·22		0·22	·0055
H_2O	3·69		3·69	·2050
			99·50	

Method of Analysis.

In the first analysis the mineral was decomposed by fusion with acid potassium sulphate. The insoluble residue of niobic acid with part of the titanic acid, left on extracting with cold water, was again fused with the sulphate. The insoluble residue left on again extracting with cold water was treated with ammonium sulphide, and then with dilute hydrochloric acid, and afterwards washed, ignited and weighed. In the water extracts the rest of the titanic acid was precipitated by long-continued boiling. The rare earths, together with iron and uranium, were then separated from calcium, &c., by a double precipitation with ammonia. The cerium and yttrium earths were separated from iron and uranium by means of oxalic acid, the iron from uranium by means of ammonium carbonate and sulphide, and the cerium from the yttrium earths by a double precipitation with potassium sulphate. The yttrium earths obtained from the filtrate after the second precipitation with potassium sulphate were slightly coloured by cerium earths, so that the number given in this analysis for the yttria is probably too high. The

titanic acid retained in the niobic acid precipitate was determined in the following way. The precipitate was brought into solution in hydrofluoric acid, and potassium fluoride added in order to test for tantalic acid. The solution was then evaporated down with a large excess of sulphuric acid, and the residue gently ignited in order to expel all the hydrofluoric acid. It was then treated with cold water in large excess, and the solution filtered from the slight insoluble residue. The titanic acid in the filtrate was then colorimetrically determined by means of hydrogen peroxide. It amounted to nearly one-half of the total percentage in the mineral.

The silica was determined in a separate portion of the powdered mineral by fusion with soda, extracting with dilute soda solution, acidifying and evaporating to dryness. The silica was estimated as the loss of weight on heating with hydrofluoric and sulphuric acids the insoluble residue thus obtained.

In the second analysis the mineral was decomposed by fuming hydrofluoric acid according to the method of Lawrence Smith (*Original Researches in Mineralogy and Chemistry*, p. 352). Most of the uranium was found in the hydrofluoric acid solution of the metallic acids.

In this analysis the cerium and yttrium earths were separated by only a *single* precipitation with potassium sulphate. The molecular weights were determined in the usual way by converting the oxides into sulphates; that for the cerium earths is only approximate since it is calculated by considering the ignited oxides as sesquioxides. An imperfect separation of the cerium from the lanthanum and didymium oxides, by precipitating with potash and saturating with chlorine, suggested that the latter oxides were present in about double the amount of the former. In stating the result of the analysis, I have preferred to give the approximate molecular weights of the yttrium and cerium earths respectively, rather than ascribe to the individual earths percentage numbers which, with our present means of separation, can have but little value.

The thoria was separated from the cerium earths by precipitation with sodium thiosulphate. After ignition and weighing, the oxide, which was perfectly colourless, was tested by dissolving in dilute sulphuric acid, evaporating the solution to dryness and gently igniting the residue to expel the excess of acid. The residue dissolved in cold water, giving a clear solution in which oxalic acid produced a precipitate insoluble in excess. On adding ammonia until neutral or even slightly alkaline, this precipitate dissolved, yielding a perfectly clear solution, in which the thoria was re-precipitated on addition of excess

of concentrated hydrochloric acid. These details are given since some discrepancies appear to have crept into the literature as to the behaviour of thorium with respect to ammonium oxalate.

The numbers obtained in the analyses suggest the formula—

$$2R_2O_3.4RO.6TiO_2.4Nb_2O_5.5H_2O,$$

$$\text{or } R'''_2(TiO_3)_3.2R'''(NbO_3)_3+3R'(TiO_3).R'(NbO_3)_2+5H_2O.$$

In chemical composition the mineral is more closely related to euxenite than to æschynite.

In the habit of the crystals, however, as mentioned above, it is very similar to the "æschynite" from Hitterö described and figured by Brögger.

It seemed advisable therefore to make at least a qualitative examination of material from crystals of the Hitterö mineral in the Museum collection.

The "Æschynite" from Hitterö.

In habit the crystals of this mineral in the British Museum correspond precisely to Brögger's description. They are tabular parallel to $b\{010\}$, and show the two prisms $n\{130\}$ and $m\{110\}$, the basal plane $c\{001\}$, with the dome $x\{021\}$, and very rarely a pyramid. Measurements made with the contact goniometer varied somewhat in different specimens, owing to the roughness of the faces, but the smaller and more perfect crystals gave values agreeing somewhat closely with those of Brögger. Thus four fairly good crystals gave $nn' = 110°$ (109°32′ of Brögger): one of these showed also the prism m and gave $mm' = 52°$ (51°26′ of Brögger); while another showed the dome x and gave $xx' = 106°$(106°44′ of Brögger). Other larger crystals, however, with more rounded faces, gave for the prism nn' angles varying from 102° to 117°, while for xx' two crystals gave an angle as low as 101°. In spite of this there was little reason to doubt that the material in the Museum collection was specifically identical with that described by Brögger.

A qualitative analysis of material from one of the crystals showed that it was similar in composition to the Swaziland mineral, and that chemically it was therefore more closely related to euxenite than to æschynite. Besides niobic and titanic acids, it contained yttrium and cerium earths (the latter in much smaller amount than the former), with iron, uranium and calcium, and little or no zirconium or thorium. The titanic acid appeared to be in larger amount than in the Swaziland mineral. This result showed that in all probability the material from Hitterö *analysed*

by Jehn[1] and termed by him *euxenite*, was identical with the crystallised material *measured* by Brögger and referred by him to *æschynite*.

Prof. Brögger in his paper (*loc. cit.*) carefully states that the mineral which from his crystallographic examination he thus refers to æschynite, may possibly be no true æschynite, but another mineral isomorphous with it, and that this can only be decided by an exact chemical analysis.

The results which I had obtained were therefore communicated to Prof. Brögger, and in reply he has very kindly furnished me with the information of that since the publication of his paper, at his request the late Prof. Blomstrand analysed specimens of the "æschynite" from both Hitterö and Arendal, and that these analyses, which have not yet been published, confirm the above result, that these minerals are chemically closely related to euxenite, and not to æschynite.

Prof. Brögger considers that, as shown in his paper, crystallographically this Hitterö mineral has nothing to do with euxenite, but belongs undoubtedly to the æschynite type, and that therefore the Hitterö mineral should receive a new name.

In the present note I have preferred to describe the mineral from Swaziland as a euxenite-like mineral and not under a new name, since, owing to the imperfect state of the crystals, its specific identity with the mineral from Hitterö is not absolutely beyond doubt.

Fergusonite?

The mineral, in the absence of crystals doubtfully referred to fergusonite, was in small rounded lenticular pebbles, and also in rounded fragments intimately intergrown with monazite.

The specific gravity of material of both modes of occurrence was practically the same (5·43 and 5·42). Qualitative analysis in each case showed the presence of water, much niobic acid, iron, uranium and yttrium earths, with very little titanic acid or cerium earths.

Cassiterite.

The specimen of cassiterite was not from the stanniferous gravels, but showed the mode of occurrence of the mineral in crystals in the matrix, a coarse-grained quartz felspathic rock, probably a vein in the granite-gneiss.

The crystals consisted of long apparently rhombic prisms (up to 2 cm. long and 3-4 mm. broad), suggesting an orthorhombic rather than a

---

[1] Jehn, *Inaug. Diss.* Jena, 1871. Analysis quoted by Dana, *Syst. Min.* 1892, p. 744.

tetragonal mineral, and it was only after chemical examination that they were referred to cassiterite.

Measurement of some crystal fragments, made by Mr. L. J. Spencer, showed that the apparently prismatic habit was due to the elongation of the crystals in the direction of the pyramidal edges [111, $\bar{1}11$]. The angle between these faces = 58°—59° (for cassiterite $ss' = 58°19'$). On two crystals, besides these s planes, terminal faces $a\{100\}$, $m\{110\}$, $e\{101\}$ were identified.

A similar apparently orthorhombic habit in tetragonal minerals has been noted, in the case of rutile by Pirsson[1], and by Miklucho-Maclay[2]; and in the case of tapiolite by Brögger[3] and by Warren.[4] Brögger (loc. cit.) shows that corresponding to columbite and tantalite are the dimorphous tetragonal forms mossite and tapiolite, and that the skogbölite of Finland is identical with tapiolite, the apparently orthorhombic habit being due to twinning about a pyramid, and to the extension of some of the pyramidal faces into a prismatic form, as in the case of this cassiterite from Swaziland.[5]

Monazite.

The specimens of monazite consist of rough tabular crystals from the gravels; the predominent pair of faces being $a\{100\}$.

By means of the contact goniometer the following forms were identified: $a\{100\}$, $m\{110\}$, $w\{101\}$, $c\{001\}$, $v\{\bar{1}11\}$, $h\{305\}$.

The specific gravity of one of the larger crystals was 4·62. Qualitative analysis showed the presence of phosphoric acid, and cerium earths with some silica and thoria. The latter was separated from the cerium earths by means of sodium thio-sulphate, and the precipitate was tested in the way described above on p. 98.

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[1] *Am. J. Sci.* XLI. 1891, 249.

[2] *Neues Jahrb. f. Min.* 1885, ii. 89.

[3] *Videnskabsselskabets Skrifter*, I *Math.-Natur. Klasse*, 1897, No. 7, Kristiania.

[4] *Am. J. Sci.* 1898, VI. 116.

[5] Since the above description was written, I have received from Prof. Molengraaff a copy of the recently published Annual Report of The State Geologist of the South African Republic for the year 1897, in which he describes and figures, in his account of the occurrence of Tinstone in Swaziland, crystals precisely similar to those described above.

On some lead minerals from Laurium, namely, Laurionite, Phosgenite, Fiedlerite, and (new species) Paralaurionite.

By G. F. Herbert Smith, B.A.,

With Chemical Analysis by G. T. Prior, M.A., F.G.S.,
Assistants in the Mineral Department of the British Museum.

[Read April 5th, 1898.]

In this paper are embodied the results of an examination of the specimens of lead slags from Laurium in the British Museum. On some of the specimens a new mineral, paralaurionite, was found, which possesses the same chemical composition as laurionite, but entirely different morphological and optical characters.

In addition to crystals of the four minerals given in the title, a few crystals of matlockite and anglesite were noticed, and on one specimen there is a radiating group of prismatic crystals of penfieldite.

I. Laurionite.

(*a*) *The morphological characters.*

Laurionite crystallises in the orthorhombic system. The axial ratios were calculated from the angles between the faces $bn^1(010:120)$ and $bd(010:012)$, and found to be—

$$a:b:c = 0{\cdot}7385:1:0{\cdot}8346$$

The following values have been previously obtained by Dr. R. Köchlin and Prof. vom Rath—

$$a:b:c = 0{\cdot}7328:1:0{\cdot}8315 \quad \text{Köchlin}^2$$
$$0{\cdot}7178:1:0{\cdot}8125 \quad \text{vom Rath}^3$$

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[1] Throughout this paper the same letters are used for the faces as in Dana's *System of Mineralogy*, Sixth Edition.

[2] *Annalen naturhist. Mus. Wien*, 1887, II. 188, and II. 83 and 127 (Notizen). Dr. Köchlin was the first to describe Laurionite.

[3] *Ber. niederrhein. Ges.* p. 150, June 6th, 1887. Prof. vom Rath took the pyramid face *p* as parametral plane. The values given above have been calculated from his measurements.

Three distinct habits were observed, of which two have already been described by Dr. Köchlin,[1] but in the case of the third the crystals are terminated entirely by new forms.

The first consists simply of the forms b(010), m(110), and n(120), lying in the prism zone, and the dome d(012).

The second is distinguished by the pyramid form p, whose indices appear to be either (151) or (141). The faces often yield more than one distinct image, sometimes three or four. In determining the position of these faces the vertical-circle devised by Dr. Stöber[2] was employed, and readings were taken of each image separately, b(010) being the pole. The polar distance (*i.e.* the angle bp) varies from 19°0′ to 27°12′, and the azimuthal angle (measuring from the prism zone) from 37°52′ to 47°47′. The values of these angles for (141) and (151), calculated from the axial ratios, are—

		Polar distance.	Azimuth.
(151)	...	19°0′	41°40′
(141)	...	24°19½′	41°40′

When this form is present, the faces of the form b are always striated parallel to their intersections with p, and give multiple images, and the crystals, owing to the oscillation of b with p, often taper towards the top. It would appear that the faces of the form p are vicinal, and possibly due to etching.

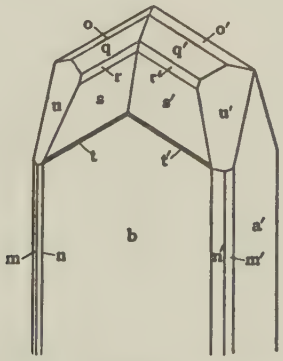

Fig. 1.

The third habit (Fig. 1) is remarkable for a number of new pyramid

[1] *Loc. cit.*, where figures of the two types may be seen.

[2] *Zeits. Kryst. Min.* 1897, XXIX. 25. Abstract in this vol. p. 52.

forms:—$o\{112\}$, $q(122)$, $r(132)$, $s(142)$, and $t(152)$, lying in a zone with $b(010)$, and $u(232)$.

In all the following forms have been observed on these crystals:—

$b(010)$ The largest face. Gives good image except in the case of crystals with the pyramid form p.
$a(100)$ Small, gives distinct image.
$m(110)$ Good image.
$n(120)$ Smaller than m, but usually gives better image.
$d(012)$ Small, but gives good image.
$p(151)$ or (141) See above.
$o(112)$ Small; image poor, but only once measured.
$q(122)$ Large; good image.
$r(132)$ Small; image poor.
$s(142)$ Large; good image.
$t(152)$ Minute; image only once seen.
$u(232)$ Large; good image.

In the following table will be found the calculated and observed values of the measured angles:—

Angle.		Calculated.	Observed Mean.	Limits.	Edges.
010 : 120	*bn*		34°6′	33°59′ —34°17′	26
010 : 110	*bm*	53°33′	53 45	53 17 —54 14	26
010 : 012	*bd*		67 21	67 16 —67 28	7
010 : 112	*bo*	70 2	69 34		1
010 : 122	*bq*	54 0	54 1	53 21 —54 24	6
100 : 122	*aq*	66 33	66 29	66 25½ —66 34½	4
010 : 132	*br*	42 32½	42 24	41 29 —42 59	6
010 : 142	*bs*	34 32	34 34	34°18′, 34°41′, 34°43′	3
010 : 152	*bt*	28 50	29 4		1
100 : 232	*au*	54 48	54 40		1
010 : 232	*bu*	50 19½	50 32	50°26′ —50°39′	4

The crystals are about 3-4 mm. in length.

(*b*) *The optical characters.*

Little information is to be obtained by placing a crystal between the crossed nicols of a polariscope. On looking through b, usually the only large face, no interference figure can be seen, and it would appear that the plane of the optic axes is parallel to this form. Among all the crystals observed only one possessed faces of the form a large enough for optical purposes. In this case an ordinary biaxial figure was

seen, but even when cedar oil was employed the "eyes" did not come into the field of view. If we assume that the acute bisectrix is perpendicular to a, the crystals are optically negative.

The prisms available for the determination of the principal indices of refraction are those given by the forms bm and mn. Since these are not symmetrical with regard to a plane of symmetry, the labour of calculation is considerably increased. It was not found possible to avoid this difficulty; the interior angles of prisms belonging to the same form are, with one exception, too large (the exception is dd', 45°18′, but unfortunately the crystals are never doubly terminated), and it is impossible to produce artificial faces on such small crystals.

Observations were made of the deviations of the two rays corresponding to different angles of incidence in sodium light, and the indices were deduced from the formulæ due to Sir George Stokes.[1]

A central section of the wave-surface by a plane parallel to (001) gives two curves, a circle and an ellipse—

$$\left.\begin{aligned} x^2+y^2&=c^2 \\ a^2x^2+b^2y^2&=a^2b^2 \end{aligned}\right\}$$

Where $a={}^1/\alpha$, $b={}^1/\beta$, and $c={}^1/\gamma$; $\alpha\,\beta\,\gamma$ being the principal indices of refraction. The image, which corresponds to the circle, and whose plane of polarisation is at right angles to the prism edge, behaves exactly as if the crystal were isotropic. We have therefore in this case the formulæ—

$$\tan\left(r_1-\frac{A}{2}\right)=\tan\frac{A}{2}.\tan\left(i-\frac{A+D_1}{2}\right)\cot\frac{A+D_1}{2}$$

$$\gamma=\sin i\,/\sin r_1$$

Where A is the prism angle, i the angle of incidence, D_1 the angle of deviation, and r_1 the angle of refraction at the incident face.

The second image, which corresponds to the ellipse, and whose plane of polarisation is parallel to the prism edge, gives formulæ involving the remaining two indices of refraction—

$$\tan\left(r_2-\frac{A}{2}\right)=\tan\frac{A}{2}.\tan\left(i-\frac{A+D_2}{2}\right)\cot\frac{A+D_2}{2}$$

$$p=\sin r_2\,/\sin i,\ \psi=\frac{\pi}{2}+\left(r_2-\frac{A}{2}\right)$$

$$p^2=a^2\cos^2(\psi-\mu)+b^2\sin^2(\psi-\mu).$$

Where D_2 is the angle of deviation, r_2 the angle of refraction at the inci-

[1] G. G. Stokes, "On a formula for determining the optical constants of doubly refracting crystals," *Camb. and Dub. Math Journal*, 1846, I. 183. *Cf.* Liebisch, *Physikalische Krystallographie*, Leipzig, 1891, p. 394.

dent face, and μ the angle between the plane bisecting the prism angle and the face (100).

We obtain several equations for a and b, and solve them by the method of least squares.

It should be remarked that in the determination of a and b we have to find the semi-axes of an ellipse, being given the lengths of perpendiculars from the centre on tangents, and the angles these perpendiculars make with one or other of the axes. If the values obtained are to be accurate, observations should be taken over as much of a quadrant as possible. Observations taken near the extremity of an axis will give an accurate value of this axis, but not of the other, whilst those in the middle of the quadrant will give values of both axes of about equal accuracy.

The images given after refraction through the prisms *bn* and *mn* were so good that in the former case 16 different angles of incidence were used, varying from about 23° to 78°, and in the latter 10 different angles, varying from 22° to 68°. The resulting values of $(\psi - \mu)$, *i.e.* the angle the perpendicular makes with an axis—in this case the normal to (010) —vary from 6° to 28° in the first, and from 45° to 60° in the second case. Since then one set of observations is taken near the extremity of an axis and the other near the middle of the quadrant, we may reasonably expect the resulting values to be fairly accurate.

Since the faces of the prism do not belong to the same form, it is necessary to notice on which face the light is incident, for except when a minimum the deviation of the extraordinary ray for the same angle of incidence will not be the same in the two cases.

The following are the values of the principal indices of refraction for sodium light—

$$\alpha = 2{\cdot}0767$$
$$\beta = 2{\cdot}1161$$
$$\gamma = 2.1580 \text{ (varying from } 2{\cdot}1499 \text{ to } 2{\cdot}1658).$$

Whence we see that the plane of the optic axes is parallel to (010).

The acute bisectrix is perpendicular to (100), and the angle between the optic axes in the crystal is found on calculation to be 81°32′. The rays parallel to these axes do not emerge through the face (100) into air, and even when the medium is a highly-refracting liquid the angle is too large for the "eyes" to be visible in the polarising microscope.

II. Phosgenite.

The crystals of this mineral are remarkably colourless and transparent, and have very smooth faces. The observed forms are: $c(001)$, $a(100)$, $m(110)$, $h(210)$, $o(201)$, $x(111)$, and $s(211)$. The values of the measured angles are almost identical with those obtained by Koksharov on crystals from Monte Poni.[1]

The prisms formed by the faces $hh^5(210:\bar{1}\bar{2}0)$ and $ah^3(100:\bar{2}10)$ were used in the determination of the refractive indices. The means of ten values for sodium light are—

$\omega = 2{\cdot}1181$ Limits 2·1158—2·1205
$\varepsilon = 2{\cdot}1446$ 2·1423—2·1467

III. Fiedlerite.

(*a*) *The morphological characters.*

Thin tablets of this mineral mingled with crystals of laurionite were occasionally observed. The habit is identical with that described by Prof. vom Rath.[2] On only a few of these tablets were the faces found to give on reflection distinct images. The observed forms are: $a(100)$, $c(001)$, $m(110)$, $n(650)$, $d(101)$, $x(\bar{1}01)$, $y(\bar{2}01)$, $e(154)$ and $o(554)$; of which $d(101)$ is new. Prof. vom Rath chose o as the parametral plane, and found for x the indices $(\bar{5}06)$; those of m are the same as above, namely (110). There are two reasons for the change of parameters here made: the form o has been rarely observed, and, if it be used to determine the axial ratios, the resulting indices for the prism forms are not simple.

System: monoclinic. Axes $a : b : c = 0{\cdot}8299 : 1 : 0{\cdot}7253$; $\beta = 77°31'$. The following table gives the calculated and observed values of the measured angles:—

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[1] *Mat. Min. Russl.* 1881, VIII. 118.

[2] *Ber. niederrhein. Ges.* p. 154, June 7th, 1887.

Angle.	Calculated.	Observed Mean.	Limits.	Edges.
100 : 001 *ac*		77°31′	77°16′—77°39′	10
100 : 101 *ad*		41 51	41 31 —42 10	5
100 : 110 *am*		39 1	38 34 —39 24	7
$\bar{1}00$: $\bar{2}01$ *a′y*	32°30½′	32 33	32 18 —32 50	7
$\bar{1}00$: $\bar{1}01$ *a′x*	56 1	56 13	55 51 —56 29	7
100 : 650 *an*	34 2	33 46	33°33′, 33°37′, 34°8′	3
100 : 154 *ae*	71 45	71 41	71 12 , 71 54 , 71 56	3
100 : 554 *ao*	45 12	44 46		1
[010]:[$0\bar{4}5$] *cao*	42 12	41 48	41°34′—41°57′	4

The tablets are never more than 5 mm. square. A few crystals were twinned about *a*.

(*b*) *The optical characters.*

On placing a tablet between the crossed nicols of a polarising microscope and using monochromatic light, an interference figure may be seen. The axis of crystalline symmetry is the obtuse bisectrix, and the acute bisectrix is inclined at a small angle to the normal to *a*. The sign of the birefrigence is negative.

The prism *ay* was employed to determine the principal indices of refraction, and the same method used as in the case of laurionite, but the angle μ is no longer constant for different colours, and cannot be determined from the geometry of the crystal. It is difficult to find μ accurately, and hence the values obtained for α and γ can only be regarded as approximate.

The values obtained for sodium light are—

$\beta = 2{\cdot}1023$, mean of 16 values ranging from 2·0988—2·1090
$\gamma = 2{\cdot}026$ approx.
$\alpha = 1{\cdot}816$,,

The angle between the normal to (100) and the acute bisectrix is about 6°.

IV. Paralaurionite, a new mineral.

(*a*) *The morphological characters.*

Crystals of this mineral may at a cursory glance be easily mistaken for laurionite or fiedlerite, according as their form is prismatic or tabular. The crystalline symmetry is monoclinic, but almost always pseudorhombic owing to twinning.

The axial ratios have been calculated from the angles *am* and *ap*, and the angle β (100 : 001) has been measured direct. These constants are—

$$a : b : c = 0{\cdot}8811 : 1 : 0{\cdot}6752\,;\ \beta\ (100 : 001) = 62°47'.$$

Two types of crystals have been observed: tabular (Fig. 2), the faces of the form *c* at the back being usually given by cleavage on extracting the crystal; and prismatic, elongated parallel to the edge *ac*, and terminated at one end only without the form *p*.

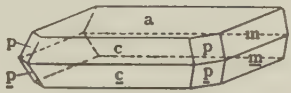

Fig. 2.

The following forms have been observed—

a(100) Large; image good.
c(001) Small; image distinct. This is the cleavage face.
d(10$\bar{1}$) Minute; image bad.
h(20$\bar{1}$) Small; image distinct.
k(40$\bar{1}$) Small; image poor.
l(60$\bar{1}$) Small; image poor.
p(111) Large; image good.
m(110) Large; image good.

The following table gives the calculated and observed values of the measured angles—

Angle.		Calculated.	Observed Mean.	Limits.	Edges.
100 : 001	*ac*		62°47′	62°16′—63°53′	31
100 : 10$\bar{1}$	*ad*	76°48½′	77 0	75 52 —77 42	4
100 : 20$\bar{1}$	*ah*	45 24½	45 24	45 19 —45 50	9
100 : 40$\bar{1}$	*ak*	21 55	21 34	20 57 —22 45	9
100 : 60$\bar{1}$	*al*	14 5	13 53	13°49′, 13°50′, 14°0′	3
100 : 110	*am*		67 25	67°22′—67°36′	16
100 : 111	*ap*		58 28	57 55 —58 46	16
001 : 111	*cp*	52 37½	52 39	52 33 —52 43	4
001 : 110	*cm*	79 53	79 55	79 30 —80 12	6
[010]:[01$\bar{1}$]	*cap*[1]	60 59	61 7½	61°3′, 61°12′	2

The prismatic crystals are often as much as 5 mm. in length, and the tablets as much as 15 × 10 mm. in area.

[1] Three crystals only were measured with the vertical circle.

(b) The optical characters.

The interference figure seen through *a* in *monochromatic* light (very little can be seen in white light) is similar to that visible through the face (100) of a diopside crystal, twinned about that face,[1] and as in this case the relative size of the two sets of rings depends on the relative thickness of the two individuals. The interference figure affords the simplest method of distinguishing between crystals of this mineral and those of laurionite and fiedlerite; for laurionite gives no figure at all through the large face, and fiedlerite a biaxial figure which is not central.

Although the crystals measured were invariably twinned, the principal index of refraction in the direction perpendicular to the plane of symmetry could be determined in the usual manner. Using the prism formed by the faces $a(100)$ $k(\bar{4}01)$, three values were obtained for sodium light: 2·1445, 2·1447 and 2·1497, the mean of which is 2·1463.

(c) The chemical composition.

By means of the optical criterion given above, as much material as possible (0·1360 gram) was carefully picked out for the chemical analysis which was made by Mr. G. T. Prior. The composition agrees closely with that of laurionite—

	Paralaurionite.	Calculated PbClOH.
Pb ...	78·1 ...	79·7
Cl ...	14·9 ...	13·7
H_2O ...	3·4 ...	3·5
O (by diff.) ...	(3·6) ...	3·1
	100·0	100·0

Water is given off at about 180° C.: it is given off at 142° C. in the case of laurionite. The specific gravity (the weight of 1 cc.) is 6·05 at 18° C.

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[1] Cf. Liebisch, *Physikalische Krystallographie*, Leipzig, 1891, Tafel VI, Figs. 4, 5, and 6.

Communications from the Oxford Mineralogical Laboratory.

Mineralogical Notes: Zinc-Blende; Galena; Pyrites; Lead.

By Prof. H. A. Miers, M.A., F.R.S.,

With Analyses by E. G. J. Hartley, B.A.

[Read Nov. 15th, 1898.]

1. *Zinc Blende with Metallic Lustre.*

A SPECIMEN in the University Museum consists of black tetrahedral blende, exhibiting perfect *metallic* lustre; indeed, the brilliant steely cleavage surfaces of the mineral and its metallic tarnish raised a doubt whether it could really be blende; but in very thin fragments viewed by transmitted light it is seen to be brown in colour.

The crystals are bright tetrahedra, a combination of {111} {1$\bar{1}$1} {110} {211} {2$\bar{1}$1}, and are accompanied by chalcopyrite, quartz and kaolin, on a matrix of chloritic vein-quartz containing iron pyrites. The locality of the specimen is not known, but it may well be Cornish.

Mr. E. G. J. Hartley analysed the mineral at my request with the object of ascertaining whether the metallic appearance is due to any unusual constituent. He obtained the following numbers:—

				Calculated for 5ZnS.FeS.
Zn	...	56·83	...	56·72
Fe	...	9·29	...	9·77
Cu	...	·07		
Mn	...	trace		
S	...	33·42	...	33·51
		99·61		100·00

Thus the mineral is a ferriferous zinc-blende corresponding almost exactly to the formula 5ZnS.FeS. The specific gravity estimated on 1·1314 gram is about 3·8.

The lustre is so unlike that of ordinary blende, that the question arises whether the union of ZnS and FeS in *molecular* proportions has not given rise to a mineral having properties distinct from those of a mere isomorphous mixture of the two sulphides.

2. *Zinciferous Galena.*

A small specimen of galena in the University Museum consists of brilliant cubes of galena disposed on quartz and associated with a little iron pyrites. The corners of the cubes are truncated by faces of the octahedron, which exhibit a very marked laminar structure.

The following analysis by Mr. Hartley shows that the mineral contains nearly 5 per cent. of zinc, although no traces of zinc-blende are observed when the crystals are finely crushed.

				Calculated for 4PbS.ZnS.
Pb	...	78·47	...	78·63
Zn	...	4·97	...	6·17
Fe	..	·67		
S	...	15·07	...	15·20
		99·18		100·00

The mineral therefore corresponds to the formula 4PbS.(Zn,Fe)S, in which, as in the preceding mineral, the proportions are molecular.

Many examples of zinciferous galena have been previously recorded, but in none of them has the substance been in such distinct crystals as in the present instance, and there is no certainty that they were not mixtures of galena and blende.

The present specimen is stated to be from Bingham, Salt Lake, Utah.

Through the kindness of Professor J. E. Talmage I have received a specimen of the massive galena from the same locality. This specimen contains no zinc, but only a small proportion of iron.

3. *A tetartohedral (?) crystal of Pyrites.*

A specimen of pyrites which has the appearance of the well known specimens from Gilpin Co., Colorado, and is probably from that locality, presents the peculiarity shown diagrammatically in Fig. 1.

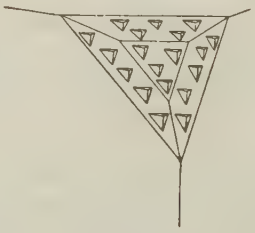

Fig. 1.

The crystals are brilliant combinations of cube with the pentagonal dodecahedron {210}, and are associated with a little galena and blende. The corners of the cubes are rough, and present at first sight the aspect of a rounded etched surface. Closer inspection shows that the cube corners are really replaced by brilliant faces of {111} and {211}, but that these faces are penetrated by a number of parallel and minute sub-individuals whose corners project so as to constitute a drusy surface. These latter corners are simply formed by cube faces without a trace of the octahedron or of {211}. They are clearly not etched planes, nor are they merely small individuals deposited on the large cubes; for they emerge from the latter, and near the edges they can be traced continuously into it.

I would suggest that these are completely interpenetrant twinned crystals of tetartohedral habit in which an unmodified cube corner of one individual protrudes through each tetrahedron face of its companion. They are in that case analogous to the twins of sodium chlorate, or to those growths of ullmannite which I have previously described as evidence of the tetartohedral nature of that member of the pyrites group (*Min. Mag.* 1891, IX. 211).

Further evidence of twinning is afforded by very minute facets barely discernible on the edges of the small projecting cubes; these are faces of {120} supplementary to those on the adjacent part of the large crystal. The same twinning probably accounts for the presence of the two supplementary forms {210} {120} on the crystals from the same locality described by E. F. Ayres (*American Journ. Sci.* 1889, 37, 236).

4. *On some Crystal Forms of Lead: a study in crystal-measurement.*

[Read June 21st, 1898.]

WHEN a piece of cast lead is subjected to the action of dilute nitric acid, it becomes etched in such a way that the surface is divided into drusy patches, each of which has a silky appearance, and can be distinguished from its neighbours when a bright light falls upon it, since numerous points on each patch reflect light together.

This indicates that each patch belongs to one crystalline individual, and the etching proves the whole mass to have a coarsely crystalline structure like a meteoric iron or a nugget of gold. In the specimen to which this note more particularly refers, the patches (*i.e.* the constituent crystal grains) are about 3 mm. in diameter.

Examined under the microscope, the drusy surface is seen to consist of minute crystals, having in some patches a rectangular, and in others a hexagonal outline. Sometimes crystals of hexagonal contour have three

ribs radiating from the centre to the corners of the hexagon, suggestive of a skeletal growth.

In some of the patches the drusy surface is seen to consist of numbers of microscopic, but very perfect and brilliant crystals, which are ranged in parallel position. Some of these present the appearance of cubes or square prisms, but others have the aspect of hexagonal prisms terminated by pyramidal facets. The latter are so perfect that at first sight one can hardly believe them to be crystals of lead, and their appearance is so different from that of the crystals of square outline that they might well be supposed to be a hexagonal modification. On the other hand, it seems more probable that the crystalline structure of the lead is cubic throughout, and that the hexagonal outlines are due to the etched surface being nearly perpendicular to a cube diagonal, while the square outlines belong to those parts which are nearly perpendicular to a cube axis. According to this view each patch is a single crystal grain of lead on which "sub-individuals" have been developed by the action of the solvent, their habit being due to the orientation of the parent crystal and the direction in which it is intersected by the surface.

The hexagonal prisms sometimes project, either perpendicularly or obliquely, from what appears to be clearly a rough etched surface of the lead, although they are themselves perfectly smooth and bright; and Mr. A. Dick, from whom I received the specimen to which this description particularly applies, is of opinion that these crystals have not been developed by the mere etching away of surrounding material, but are deposited as lead crystals from the solvent. They certainly present a very different appearance from some negative cubes which have evidently been etched into the lead, and from some cubic outlines which remain between these negative crystals. According to this view the minute sub-individuals deposited on each patch become orientated in parallel position by the crystal on which they are laid down.

However this may be, the hexagonal prisms are crystals of the most perfect nature, with lustrous facets, and their true symmetry can only be determined by measurement of their angles.

The crystals are far too small, and in any case too soft, to be isolated and measured in the ordinary way; and indeed it seemed hopeless to attempt any goniometrical measurement of such material,

However, by taking advantage of the fact that each patch consists of a considerable number of *parallel* crystals, and by using the two-circle or theodolite-goniometer, I have been able to measure the crystals with complete success and to identify their faces.

A small etched button of the lead which I received from Mr. Dick, having been mounted on the theodolite goniometer, it was possible to make a series of measurements, taking account only of the light reflected from one of the small drusy patches. By reason of the large number of parallel facets yielding each reflection, it was easy to obtain an image from faces which were almost invisible; and although the images, as is usually the case with those reflected by a number of parallel crystals, were not perfectly sharp, they were quite reliable to three or four minutes.

Another series of measurements could then be made upon another of the drusy patches and compared with the first. The lead button can be adjusted to any convenient position at the beginning of each such series.

As a result of the measurements it was found that the hexagonal prisms have the form of Fig. 3, and that they are really a cubic combination similar to those represented in Fig. 2, but elongated along the ditrigonal axis.

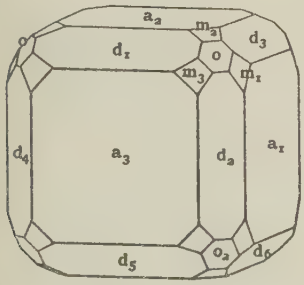

Fig. 2.

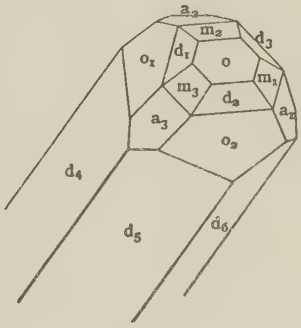

Fig. 3.

The following are the readings obtained from a single patch, A being the reading on the horizontal circle, and B the reading on the vertical circle for each face; the basal plane *o* having been adjusted perpendicular to the axis of the vertical circle, so that the image from *o* remains centred as the vertical circle B is rotated.

		A.		B.
o	...	161°11	...	...
a_1	...	286 23	...	30°35′
m_1	...	131 36	...	30 35
d_1	...	196 24	...	210 58
o_1	...	231 40	...	210 30
a_2	...	215 56	...	270 31
m_2	...	190 43	...	270 38
d_2	...	125 58	...	90 38
o_2	...	90 39	...	90 38
a_3	...	106 29	...	150 36
m_3	...	131 42	...	150 49
d_3	...	196 25	...	330 13
d_4	...	71 6	...	180 35
d_5	...	71 0	...	120 35

In the following table the readings are reduced to 0°0′ (A) for the face o, and to 0°0′ (B) for the zone $a\,m\,o$.

		A.		B.
o	...	0° 0′	...	...
a_1	...	54 48	...	0° 5′
m_1	...	29 45	...	0 5
d_1	...	35 13	...	0 28 + 180°
o_1	...	70 29	...	0 0 + 180
a_2	...	54 45	...	60 1 + 180
m_2	...	29 32	...	60 8 + 180
d_2	...	35 13	...	60 8
o_2	...	70 32	...	60 8
a_3	...	55 10	...	120 6
m_3	...	29 39	...	120 19
d_3	...	35 14	...	119 43 + 180
d_4	...	90 5	...	150 5
d_5	...	90 11	...	90 5

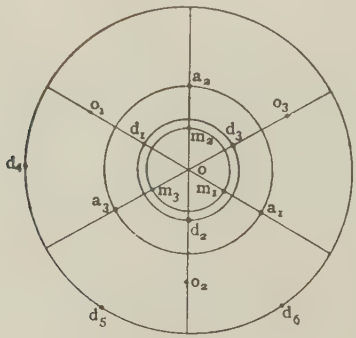

Fig. 4.

From these numbers it may be seen that the faces occupy the position shown in the accompanying stereographic projection, Fig. 4, and belong to the following forms :—

$$a\{100\},\ o\{111\},\ d\{110\},\ n\{311\},$$

for which the theoretical readings on circle A are

$$54°44',\ 70°31',\ 35°16',\ 29°30'.$$

The above observations conclusively establish the cubic nature of these apparently hexagonal crystals of lead.

This communication shows how it is possible under certain conditions to obtain accurate measurements from faces almost too small to be visible, and belonging to a crystal which cannot be isolated. Such measurements can only be made by means of the theodolite goniometer.

The method could possibly be applied to other cases of parallel crystals forming a drusy surface, such as those etched upon meteorites and gold nuggets.

Note on the Crystals of Lead described in the preceding communication.

By Allan Dick.

As Professor Miers has quoted my opinion of the manner in which the lead crystals measured by him were formed, I may state the circumstances under which I gave the opinion.

The etched button of lead was prepared by Mr. J. G. Stead, of Middlesborough, in the course of an investigation into the structure of metals, part of which has been published by the Iron and Steel Institute. The button was sent to a mutual friend, who it was hoped would be able to state exactly the crystalline system to which the hexagons belonged. My friend, finding himself unable to do so, asked me to look at the button, as he knew I had worked at lead during many years. I did so, and recognised the appearance which corroded lead presents under the microscope. As some of the patches showed the minute hexagons rather larger than usual, and well placed for inspection, I thought it a good opportunity to learn more about the hexagons than I knew, for they had long been a puzzle to me. With Mr. Stead's approval I sent the button to Professor Miers, with a request that he would, if possible, measure and describe the crystals, which he has fortunately been able to do.

When lead approaching purity, such as that used in white lead making, is cast in a mould so that the upper surface is exposed to the air, it is found that that surface presents different appearances according to the purity of the lead, the temperature of the mould, and other conditions. The surface is broken up into patches, each of which is a separate crystal. In large castings each crystal may be from an inch to many inches in diameter, and when the skin is stripped from such a solidifying mass it is seen that the skeletal octahedra beneath are differently orientated in each patch. When the facets of the octahedra are parallel to the surface, brilliant large flat planes result. When the points of the octahedra are at right angles to the surface, it presents a fern-like appearance. When the former are corroded, an hexagonal wreckage is produced, whereas the latter gives rise to a rectangular wreckage. The skeletal octahedra are not always parallel or at right angles to the surface, but sometimes variously inclined, giving rise to hexagonal or rectangular wreckage variously inclined.

In nearly pure lead the hexagonal and rectangular etched surfaces are of brilliant lustre, but never, so far as I have seen, present any pyramidal facets. When the lead is rather impure, the surfaces of the etched (negative) crystals are dull and pitted. But on either quality of lead brilliant crystals with pyramidal facets, such as Professor Miers has figured, may be formed, and I think arise from the redeposition of lead on the etched surfaces under certain circumstances.

Any one desiring to see these crystals may easily produce them as follows. Cast a small round button of nearly pure lead so that it resembles a flattened drop. Place it in an egg-cup flat side downwards, and so that there may be only a small space between the bottom of the button and the bottom of the cup. Fill the cup half full of water containing from 5 per cent. to 10 per cent. of nitric acid, and leave the whole at rest from 24 to 48 hours. Wash with water and examine under the microscope, using an inch or a half-inch object glass. Generally, but not always, a few patches of the brilliant crystals will be seen amongst the general patches of rectangular and hexagonal forms. They are easily recognised by their greater brilliance and more complex forms. I have many times seen the corners of cubes modified as Professor Miers has shown in Fig. 2. It is very interesting to see how the cubes and hexagons are related to one another.

I think these brilliant crystals, cubic and hexagonal, are formed by the electrolytic deposition of metal which is being dissolved away from the upper surface, exposed to nitric acid and nitrate of lead, and re-deposited on parts of the lower surface where the lead is exposed only to nitrate of lead; it is an instance of the deposition of metal from a circuit of two liquids and one metal.

I have seen very beautiful examples of the cubic and hexagonal structure in the "blue lead" resulting from the manufacture of white lead by the "Dutch process." In such cases the white lead detached from the blue lead, if examined under the microscope, shows perfect casts of the hexagonal and cubic structure of the corroded surface of the blue lead. They look like opaque crystals of white lead, but are only casts of the corroded surfaces.

Beautifully etched surfaces of lead may be formed by heating cast lead in a rather strong solution of nitrate of lead, and such surfaces generally have the rectangular and hexagonal structure more coarsely developed than I have otherwise seen it. It can then be seen by a $\frac{1}{4}$-inch hand lens.

Communications from the Oxford Mineralogical Laboratory.

On the constitution of the mineral Arsenates and Phosphates.

By E. G. J. Hartley, B.A.

[Read June 21st, 1898.]

Part I.—*Chalcophyllite.*

THIS mineral was originally described as a hydrated copper-arsenate. Analyses of copper-arsenate are given as far back as 1801 by Vauquelin (*Journ. des Mines*, 1801, X. 562), and by Chenevix in the *Philosophical Transactions* (for 1801); but at this early date the analyses seem to refer partly to chalcophyllite and partly to olivenite.

Subsequently analyses have been published by Hermann, Damour and Church – (1) Hermann, *Journ. prakt. Chem.* 1844, XXXIII. 294; (2) Damour, *Ann. Chem. Phys.* 1845, XIII. 413; (3) Church, *Journ. Chem. Soc.*, 1870, VIII, 168.

	As_2O_5	P_2O_5	CuO	H_2O	Al_2O_3	FeO	
Hermann	17·51	undet.	44·45	31·19	3·93	2·92	=100
Damour (i)	19·35	1·29	52·92	23·94	1·80	—	= 99·3
,, (ii)	21·27	1·56	52·30	22·58	2·13	—	= 99·84
Church	15·54	—	46·1	(31·75)	5·97	—	= 99·4

From the last analysis Church deduced the formula—

$$8CuO.Al_2O_3.As_2O_5.24H_2O \text{ (or } 25H_2O).$$

In Hermann's and Damour's analyses the water was determined by loss of weight on heating the mineral, but this method is not satisfactory, as there is always the risk of minerals of this class losing arsenic on ignition. Church only estimated the water by difference. It therefore seemed advisable to make a fresh analysis of this mineral, especially with a view to estimating the water directly.

Though the exact locality of the mineral used for analysis is uncertain, the specimens were undoubtedly old Cornish specimens, and consisted of fine pale emerald-green crystals implanted on massive cuprite, and associated with quartz and traces of malachite and chessylite.

The portion taken for analysis was very carefully picked under the microscope, and consisted entirely of clear crystals, free from any inclu-

sions except a few minute black specks which were visible in some of the crystals.

Although the mineral loses nearly 18 per cent. of water at 100 C., no change in its optical properties was observed when the crystals were heated on a sheet of mica supported over the stage of a polarising microscope until a considerable temperature was reached, when they suddenly became opaque and cracked. Under these circumstances they appeared nearly black, but when examined in sufficiently thin flakes they were seen to be yellow and devoid of double refraction. No further change was produced when the fragments were immersed in water.

A qualitative analysis was made to see if iron or phosphoric acid were present, but neither of these substances was found.

Analysis.

The water was determined by heating a weighed portion of the mineral in a porcelain boat in a hard glass tube, and collecting the water given off in a weighed calcium chloride tube.

To prevent any arsenious oxide from passing over with the water, a layer of about two inches of a mixture of lead oxide and dioxide was interposed between the boat and the calcium chloride tube. This layer was heated by means of a broad luminous flame kept about 1 inch below the tube, and it has been found that in this way all arsenic is kept back while the water passes over.

With regard to the rest of the analysis, the arsenic acid was reduced with sulphurous acid, and the copper and arsenic precipitated together in a strongly acid solution with sulphuretted hydrogen. The arsenic sulphide was dissolved out as far as possible by sodium sulphide, and the copper was redissolved and reprecipitated in one case as oxide, and in the other as sulphide, and weighed as such.

The alumina was estimated in the filtrate from the copper and arsenic by evaporating and precipitating with ammonia.

The arsenic acid was estimated in a separate portion by direct precipitation with magnesia mixture, a small quantity of tartaric acid having been added to prevent the simultaneous precipitation of alumina or copper. The percentages thus found from the analysis showed a deficit of about 7 per cent.; it was then found that sulphuric acid is present as a constituent of this mineral in such a proportion as exactly to account for the deficit. It is remarkable that this constituent has been entirely overlooked by previous analysts.

The analytical numbers are as follows :—

·2192 grm. lost at 100 C. ·0393 grm. $H_2O = 17{\cdot}93$ %
and gave further on ignition ·0233 ,, $H_2O = 10{\cdot}63$ % } 28·56 % H_2O

·2271 grm. gave	·0643	H_2O	corresponding to	28·31 %	H_2O
·2003 ,,	·0559	H_2O	,,	27·91 ,,	H_2O
·3436 ,,	·1582	CuO	,,	46·04 ,,	CuO
	·0163	Al_2O_3	,,	4.74 ,,	Al_2O_3
·2632 ,,	·1206	Cu_2S	,,	45·82 ,,	CuO
	·0125	Al_2O_3	,,	4.74 ,,	Al_2O_3
·2828 ,,	·0559	$Mg_2As_2O_7$	,,	14·66 ,,	As_2O_5
·2409 ,,	·0463	$Mg_2As_2O_7$	,,	14·26 ,,	As_2O_5
·3652 ,,	·0759	$BaSO_4$	,,	7·13 ,,	SO_3
·2423 ,,	·0491	$BaSO_4$	,,	6·96 ,,	SO_3

Taking the mean of these results the following numbers are obtained :—

(Water lost at 100 C., 17·93.)

Total	H_2O	28·26
	CuO	45·93
	Al_2O_3	4·74
	As_2O_5	14·46
	SO_3	7·04
		100·43

It seems impossible to deduce a simple formula for the mineral from these numbers, which give the following molecular ratios for the different constituents :—

H_2O	1·57
CuO	·58
Al_2O_3	·046
As_2O_5	·062
SO_3	·088

It is therefore desirable that further analyses of chalcophyllite from some other localities should be made, with a view to finding variations in the proportions of some of the constituents which might throw light on the true constitution of this mineral.

The specimens of chalcophyllite used in the preceding investigation were from the mineral collection in the Oxford University Museum, and the analyses were made in the laboratory of the Mineralogical Department.

REVIEWS.

A Text-book of Mineralogy, with an extended treatise on Crystallography and Physical Mineralogy. By Edward Salisbury Dana. New Edition, entirely re-written and enlarged. Large 8vo, 593 pp., over 1,000 figs., and a coloured plate. New York and London, 1898.

Prof. E. S. Dana's text-book of Mineralogy in scope occupies an intermediate position between elementary books in which little or no attempt is made to deal adequately with the crystallographic and optical branches of the subject, and such a work of reference as Dana's *System of Mineralogy*. The want of such a text-book in English has of late years been increasingly felt owing to the advances made in the science, especially in crystallographic and optical methods of investigation. This new edition has been entirely re-written and brought up to date, and should go a long way towards satisfying this want. The first part of the book, occupying 144 pages, is devoted to crystallography. According to the degree of symmetry they exhibit, crystals are divided into the now-accepted thirty-two groups. These are classified under the six systems, the group in each system possessing the highest degree of symmetry being called the normal group. In the introductory articles is a brief account of molecular networks or point systems, according to which these groups receive their theoretical explanation. This subject has been engaging the attention of mineralogists so much of late that we are inclined to regret that the author has not felt able to devote more space to its consideration. An intelligible summary in English of this subject, similar to that given by Groth in the last edition of his *Physikalische Krystallographie* would be very desirable at the present time.

The second part of the book, dealing with physical mineralogy, occupies 94 pages, and is mainly taken up with the optical characters of crystals. A useful feature in this as in other parts of the book is the list, at the end of each main section, of references to important papers on the subject discussed in the section. In the articles treating of optical instruments and methods, mention might have been made of the Dick microscope which has proved so eminently serviceable in the optical examination of minerals.

The whole subject of the optical properties of crystals is very fully treated, and it is shown how these can be deduced from the index-ellipsoid or indicatrix of Fletcher, the axes of which are proportional to constants capable of direct measurement, viz. the refractive indices α, β, γ, where $\alpha < \beta < \gamma$.

It is, therefore, all the more puzzling to find a later article headed "Axes of elasticity," in which it is stated that "these axes of elasticity are of great convenience in describing the optical properties of crystals, *and it is hence necessary to make frequent use of them.*" These, in fact, are the axes which, under the new name of "ether-axes," the author uses in the descriptive part of the book. He mentions, it is true, that these axes of elasticity "have the direction of the three ellipsoidal axes" (the axes of the indicatrix), but he does not clearly point out to the student that it is the a (α)-axis of the indicatrix which corresponds to the a ($\mathfrak{a}$)-axis of elasticity and so on, and accordingly that old formulæ, expressed in the language of elasticity, can be at once translated into the language of the indicatrix by substituting 'axis of indicatrix' for 'axis of elasticity,' *e.g.*, a positive biaxial crystal is one in which the c (γ)-axis of the indicatrix as well as the c ($\mathfrak{c}$)-axis of elasticity is the acute bisectrix. To the mineralogist the fact is of little concern that, regarded as an axis of the indicatrix, the c-axis is the greatest, whereas regarded as an axis of elasticity it is the least. The axes of elasticity most often employed are not those of Fresnel's ellipsoid of elasticity, which is identical in form with the indicatrix, but of its polar reciprocal. They are usually denoted by the letters $\mathfrak{a}$, $\mathfrak{b}$, $\mathfrak{c}$, where $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$, whereas the axes of the indicatrix being proportional to the refractive indices are generally denoted by α, β, γ where $\alpha < \beta < \gamma$. It is probably on this account, and to obviate the necessity of altering the lettering of old diagrams, &c., that the author has elected to retain the old axes of elasticity under their new name of ether-axes. We cannot help thinking that this is quite a needless complication, which might have been avoided by denoting the axes of the indicatrix by the letters $\mathfrak{a}$, $\mathfrak{b}$, $\mathfrak{c}$. The result of this would be that old formulæ and diagrams, illustrating the relation of the crystallographic to the light-axes, would need no alteration: it would be only necessary to remember, when any question might arise as to their relative magnitude, that in the case of the indicatrix $\mathfrak{a} < \mathfrak{b} < \mathfrak{c}$.

To the third part of the book, treating of Chemical Mineralogy, only thirty pages are devoted. The elementary principles of chemistry, as applied to minerals, are briefly but clearly explained, and reference is made to the periodic law. The subject of isomorphism and the con-

nection between chemical composition and crystalline form receives rather brief treatment. A short account is given of the blowpipe examination of minerals, but for this and kindred subjects the reader is referred to Brush's *Manual of Determinative Mineralogy*, a new edition of which, under the editorship of Prof. Penfield, has just appeared.

The fourth part of the book, on descriptive mineralogy, is " essentially an abridgment of the Sixth Edition of Dana's *System of Mineralogy*," as prepared by the author. In the case of the more important minerals, however, useful paragraphs have been added in which are given the distinguishing characters which serve to separate the species from others with which it might be confounded.

At the end of the book are appendices, one treating of the drawing of crystals and of projections, and the other containing tables of minerals, arranged according to crystal system, specific gravity, &c., which should be very serviceable for determinative purposes.

The book is not altogether free from printer's errors. In the preface the Oxford professor of mineralogy is referred to as Prof. Miers of Cambridge, on pp. 28 and 31 some of the indices of the faces are incorrect, on p. 158 the heavy liquid methylene iodide is referred to as methyl iodide, a very different substance.

As an excellent text-book of Mineralogy, and the only one in English containing a full treatment of the crystallographic and optical principles of the science according to the most recent methods of investigation, the book should meet with wide acceptance. G. T. P.

Geology for Beginners. By W. W. Watts, M.A., F.G.S., Assistant-Professor in Geology at the Mason University College, Birmingham. 8vo, 352 pp., 310 figs. London, 1898.

This excellent little text-book of geology forms one of Macmillan's Elementary Science Series. Although intended for use in preparation for the elementary stages of the Science and Art examination, it has none of the objectionable features of the ordinary cram-book.

The treatment is necessarily of an elementary character, but for its size the book contains a really marvellous amount of information arranged in admirable fashion to meet the needs of the student.

The general " plan of work " as set forth by the author in the first chapter explains well the excellent mode of treatment adopted and the general aim of the book. First, common rocks are pulled to pieces, and studied at home. Then are noted their mode of occurrence and appear-

ance in the field. After which the various geological changes taking place at the present time are explained, so that the student may duly appreciate the way in which rivers carve out their valleys and seas tear down their cliffs, and deposit the relics, in the one case in deltas and river basins, and in the other on the sea-bed. From the study of what is actually occurring at the present day the student is then taught to deduce what has happened in the past and to "find out how the rocks succeed one another, and what points in the history of life or geography each one yields." At the end of the book, after the different geological systems have been described, is an instructive and interesting chapter on the origin of landscape, and finally a rather short chapter on economic geology.

A prominent feature of the book is the number and excellence of the illustrations. As is well known, the author, as secretary to a British Association Committee, has been zealous in directing the attention of geologists to the advisability of collecting and preserving photographic records of interesting geological features. The number of reproductions of such photographs taken by various observers, which adorn the pages of his book, seem to show that the author has begun to reap some advantage from his labours. Many of the other illustrations have been taken from Zittel's *Grundzüge der Paläontologie.*

The book appears to be remarkably free from printer's errors. The following are a few points we have noted to which exception may be taken. The granite figured on p. 9 is not a very typical example of granitic structure. The chemical composition of a felspar is not very well expressed by the statement on p. 36, that it is "a compound of two substances, known respectively as silicate of potash and silicate of alumina." On p. 122, trimetric is used instead of the more usual orthorhombic. On p. 126, magnetite is described as crystallising in dodecahedra, whereas if only one habit of the crystals is mentioned octohedra are far more common. On page 130, chlorite is referred to the hexagonal system. On p. 168, tachylyte is spelt 'tachylite.'

These, however, are but very minor points, and do not seriously detract from the value of a book which, in our opinion, is by far the best elementary treatise on geology which has appeared within recent years.

G. T. P.

Manual of Determinative Mineralogy, with an introduction on Blowpipe Analysis. By George J. Brush. Revised and enlarged with entirely new tables for the identification of minerals by Samuel L. Penfield.

New York (John Wiley and Sons), London (Chapman and Hall, Ld., 1898). Large 8vo, 312 pp., 375 figs.

The first edition of this book, by Prof. G. J. Brush, appeared in 1874, and the present is the 15th edition. This fact alone testifies to the great popularity of the work.

In 1896, a first instalment of the present edition was issued, with the introductory chapters entirely re-written by Professor Penfield, but with the old tables, and was reviewed in this Magazine (vol. xi. 219). The work now re-appears in a complete form, as a new book, with the determinative tables revised, and with a new chapter of 84 pages on the Physical Properties of Minerals. This chapter is the simplest and most intelligible summary of the principles of crystallography that has yet been given to the elementary student, and is a very noteworthy feature of the book; especially satisfactory are the diagrams by which the symmetry of the 32 crystalline types are illustrated and the order of their symmetry axes depicted.

In the very complete tables for the determination of mineral species which constitute the latter half of the book, the following classification is adopted:—I. Minerals with metallic lustre; II. Minerals without metallic lustre. Within each of these classes the species are grouped by their fusibility. In class I. the fusible minerals are further distinguished by blowpipe reactions as arsenic, selenium, tellurium and antimony compounds, and sulphides, while the infusible minerals include iron and manganese compounds. In class II. the fusible compounds include (1) those which yield globules of silver, lead, bismuth, antimony and copper; (2) the iron compounds, which become magnetic; (3) certain arsenates, phosphates, borates, silicates, and salts of the alkali, and alkali-earth metals. The infusible compounds comprise the remainder.

Practically all the known species are included in these tables, but the more common are printed in conspicuous type. It is stated in the preface that all the tests have been carefully verified, and many have been devised specially for the present work. The real value of the book can only be ascertained by its practical use. We may confidently expect that it will be found to fulfil all the requirements of the student.

Should Professor Penfield feel able to include a chapter on the optical examination of crystals in a future edition without increasing the book to an inordinate size, it will become a complete handbook, with the aid of which a skilful student should be able to identify any known mineral, including even the rarer species.

The Boy Mineral Collectors. By Jay G. Kelley, M.E. 362 pp. (Philadelphia : J. B. Lippencott Company, 1899).

This is a story, in conversational form, of the doings of two boys while on a visit to their mining uncle in Colorado. Instead of profitably spending their time in collecting minerals in the open, they spend most of it talking in the library. There are popular chapters on "Metals of great value," in which vanadium is quoted at 2,240 dollars per pound ; "A lesson on pearls and rubies" ; "A chat on silver and diamonds," &c. Information on any one subject is much scattered, and is not always quite accurate ; the names of minerals are sometimes incorrectly spelt. As a story the book is a failure.

OBITUARY.

Andreas Arzruni.

ANDREAS ARZRUNI, born at Moscow on November 27th, 1847, was the last male descendant of the ancient Armenian family Arzrunier, which, from the 11th century until the conquest of Armenia by the Turks in the 16th century, held the Principality of Waspurakan, of which Van was the capital.

After a short stay at the St. Petersburg University, Arzruni migrated to Heidelberg, where he studied chemistry under Bunsen. He then (1872) for a time assisted Prof. Groth at Strassburg, and in 1877 became Privatdocent in the Berlin University. From 1880 to 1883 he acted as Assistant in the Mineralogical Museum at Berlin, of which Websky was then director. In 1883 he was appointed Extraordinary Professor at Breslau, and a year later Ordinary Professor of Mineralogy in the Technical High School at Aachen, which post he held till the last. In the winter of 1895-6, while on a visit of inspection to the gold fields of British Guiana, he had an attack of fever, and this, together with consumption, compelled him to spend the last year or so in sanatoria in Switzerland and on the Rhine. He died on September 22nd, 1898, and was buried at Tiflis, his Armenian home.

Arzruni was the author of some 50 papers published in various scientific journals, including Russian and Italian. Notices of a few of these have appeared in the *Mineralogical Magazine*. His first paper, published in 1871, was on a chemical subject; others in ethnological journals related to prehistoric stone implements, especially those of jade and jadeite; and several were descriptive of the minerals and rocks collected on his journeys in the southern Urals. Two minerals, groddeckite and utabite, were first described by him, and before his illness he was investigating a new Chilian mineral, the description of which still remains unpublished. His best known work, however, is *Die Physikalische Chemie der Krystalle* (1893), this being a subject which he had especially studied; and the book displays evidence of an immense amount of bibliographical research. (A more detailed account of his life is to be found in *Zeits. prakt. Geol.*, 1898, 446-8.)

ABSTRACTS.

Scottish Minerals. The third part of Vol. VII. of the *Trans. Edinburgh Geol. Soc.* 1897, contains several papers of mineralogical and petrological interest. Many of them are illustrated with plates.

H. M. Cadell (p. 173) has a note on the occurrence of vivianite in an old lake bed at Cauldhame, near Linlithgow. The mineral incrusts bone and pieces of stone, or is mingled with earth and peat.

J. G. Goodchild (pp. 201-2) describes the minerals of the Hilderston silver mines, Linlithgow. They include calcite, barytes, argentiferous galena, and the rarer minerals niccolite, annabergite and erythrite.

J. Currie (pp. 223-9) describes various secondary minerals from the volcanic rocks of Ben More in Mull. Scolecite occurs as radiated groups of crystals sometimes 10 cm. long. Epidote is found in good crystals. Dark green celadonite is very abundant, whilst saponite is rare. Heulandite, stilbite and prehnite are also found. To account for the abundance and unusual associations of these minerals, pneumatolytic action is assumed. The same author (pp. 252-3) gives a crystallographic description of apophyllite from Kimberley, S. Africa, a figure of a Scotch crystal being added for comparison.

M. F. Heddle (pp. 241-3) figures crystals of analcite from the Boylestone quarry near Barrhead in Renfrewshire. Besides {211}, there are small faces of the forms {100}, {332}, {*h l l*} and two hexakisoctahedra, possibly {543} and {421}, but no measurements are given. The crystals show good corrosion figures, and are not composite in structure. They are small and colourless, and occur with prehnite, thomsonite, and large crystals of white opaque analcite. A second paper (pp. 265-7) by the late Prof. Heddle is on the crystalline form of riebeckite from Ailsa Craig: two plates, illustrating the various forms observed, are given. L. J. S.

Mossite, and the crystalline form of Skogbölite. (W. C. Brögger, *Vidensk. Skrifter, I. Math.-nat. Klasse, Kristiania*, 1897, No. 7, pp. 1-19).—The new mineral, mossite, occurs with yttrotantalite and columbite in a pegmatite vein at Berg in the parish of Råde, near Moss, in Norway. The tetragonal crystals are black with sub-metallic lustre;

they are usually twinned on (101) and elongated in the direction of the pyramid edge [111, 1$\bar{1}$1], then having the appearance of simple orthorhombic crystals of prismatic habit. Analysis by G. Thesen gives the formula $FeNb_2O_6.FeTa_2O_6$. Sp. gr. = 6·45.

In the following isodimorphous group the tetragonal members are homœomorphous with rutile, xenotime, etc., and the orthorhombic with brookite.

		Tetragonal.	Axis *c*.	Orthorhombic.
$Fe(Ta,Nb)_2O_6$	...	Tapiolite	0 6525.	Tantalite.
$Fe(Nb,Ta)_2O_6$	...	Mossite	0·6438.	Columbite.

The so-called tantalite from Tammela in Finland (= skogbölite), which was described as orthorhombic with a form more or less closely related to that of columbite, is now shown to be identical with tapiolite, the crystals being really tetragonal and twinned like mossite. The skogbölite forms :

r(490), *a*(100), *μ*(011), *b*(010), *q*(031), *n*(016), *v*(322), *p*(111), *o*(211),

as given in Dana's *Mineralogy*, p. 736, are the tapiolite forms :

(111) (010) (100) (101) (301) (30$\bar{1}$) (110) (320) (230)

respectively. Twinning on *b*(010) was stated to be common in skogbölite, but this, being a plane of symmetry in an orthorhombic crystal could not be a twin plane ; it is the twin plane 101 of tapiolite.

C. H. Warren (*Amer. Journ. Sci.* 1898, VI, 121) has described simple and twinned crystals of tapiolite from the felspar quarries at Topsham, Maine. The twinned crystals have the same orthorhombic habit as mossite. L. J. S.

Heavy Liquid for separating Minerals. (W. Muthmann, *Zeits. Kryst. Min.* 1898, XXX. 73-4).—Acetylene tetrabromide, $CHBr_2-CHBr_2$, which may be easily prepared by passing acetylene into bromine, has sp. gr. = 3·0011 at 6°, and refractive index = 1·6479 for sodium light. It is stable, and does not darken on exposure to light ; it has no action on metallic minerals, and is miscible in all proportions with benzene, ether, etc. : and it is less than one-tenth the cost of methylene iodide (sp. gr. = 3.35). L. J. S.

Dehydration of Analcite. (Georges Friedel, *Bull. Soc. franç. Min.* 1896, XIX. 363-390).—The amount of water given off by analcite at a definite temperature is dependent on the tension of aqueous vapour in the air. It is therefore necessary when determining the amount of water

lost on heating zeolites to observe the tension of aqueous vapour as well as the temperature. Constant results are only obtained when the powdered mineral is heated in a rapid current of dry air. If, after dry air has been used, a current of moist air be passed over the heated mineral, there is, in spite of the elevated temperature, an absorption of water, and to expel this again with the same tension of aqueous vapour a higher temperature is required. Equilibrium in such cases is more rapidly established the higher the temperature; that is, water is more slowly re-absorbed the lower the temperature. L. J. S.

Constitution of Mispickel. (F. W. Starke, H. L. Shock and E. F. Smith, *Journ. Amer. Chem. Soc.* 1897, XIX. 948-952; compare abstr. XI. 105).—Mispickel (FeAsS) has been considered to be FeS_2 with the sulphur partly replaced by As″, or $FeAs_2$ containing S‴. In attempting to determine the true constitution of the mineral, the following experiments were made.

When heated in hydrogen only sulphur is expelled. Under similar conditions pyrites and marcasite lose half their sulphur. Heating with copper sulphate solution in sealed tubes, or with ammonium chloride, showed the presence of much ferrous iron and As‴, and only a little ferric iron. The amount of ferrous iron was determined to be about 30½ per cent. by heating the mineral in a current of dry hydrogen chloride. Since mispickel contains 34·35 per cent. Fe, this leaves about 4 per cent. for ferric iron.

The formula of mispickel is therefore provisionally given as 14Fe″As‴S. 2Fe‴As‴S. Experiments to determine the molecular weight by observing the influence of mispickel on the solidification point of alloys were without result. L. J. S.

Krennerite from Cripple Creek, Colorado. (A. H. Chester, *Amer. Journ. Sci.* 1898, V. 375-377).—This mineral has previously only been known from Nagyag in Transylvania. It has now been found as bright crystals associated with quartz and pyrites at Cripple Creek. The colour is pale yellowish bronze, but on the perfect basal cleavage it is tin-white. Measurements by Penfield are given of the orthorhombic crystals, and analysis by W. S. Myers gives the formula $AuTe_2$; only 0·45 per cent. of silver is present.

The compound $(Au,Ag)Te_2$ appears to be trimorphous, being orthorhombic in krennerite, monoclinic in sylvanite, and probably anorthic in calaverite (Abstr. XI. 235), though the last two may be identical, only differing in the amount of silver present. L. J. S.

Orthoclase as a gangue mineral in fissure veins. (W. Lindgren, *Amer. Journ. Sci.* 1898, V. 418-420).—A review is given of the few recorded occurrences of felspars in mineral veins, and a new occurrence is described. A vein on Florida Mtn. in the Silver City mining district of southern Idaho contains pyrites, copper pyrites and argentite, with a gangue of quartz and orthoclase; it is richest in orthoclase where it traverses granite, there is less where it intersects rhyolite, and none where it intersects basalt. The orthoclase occurs as large irregular milk-white grains intergrown with vein-quartz and enclosing pyrites and argentite, or as crystals coating quartz and lining crevices in the altered granite adjoining the vein. The crystals are of the adularia habit, with the forms $m\{110\}$ and $x\{\bar{1}01\}$. An analysis by Hillebrand is given.

That orthoclase has been formed artificially in the wet way supports the idea that this vein of orthoclase has been formed by aqueous deposition. Its comparatively rare occurrence may possibly be due to the frequent presence of carbonated thermal waters in mineral veins. L. J. S.

Rhodolite, a new Garnet. (W. E. Hidden and J. H. Pratt, *Amer. Journ. Sci.* 1898, V. 294-296).—A "rose garnet," named rhodolite on account of its rose-red or rhododendron-red colour, occurs as rolled pebbles in the gravels of a brook called Mason's Branch, in Macon Co., North Carolina. It is unusually free from internal flaws and inclusions, and forms a fine gem-stone, which in brilliancy resembles the green demantoid of the Urals. Sp. gr. = 3·837. Analysis gives the formula, $2Mg_3Al_2(SiO_4)_3 + Fe_3Al_2(SiO_4)_3$, *i.e.* two molecules of pyrope with one of almandine. L. J. S.

Clinohedrite, a new mineral. (S. L. Penfield and H. W. Foote, *Amer. Journ. Sci.* 1898, V. 289-293).—This is associated with willemite, garnet, phlogopite, axinite and datolite at the Trotter mine, Franklin, New Jersey. The monoclinic crystals are interesting on account of their hemihedrism, there being a plane of symmetry but no axis of symmetry (domatic class). Owing to the absence of parallel faces (except $b(010)$) the crystals present a peculiar inclined-faced character, hence the name clinohedrite; $a : b : c = 0·6826 : 1 : 0·3226$; $\beta = 76°4'$. There is a perfect cleavage parallel to $b(010)$. H = 5·5; sp. gr. = 3·33. The crystals are pyroelectric; they are often transparent, and the colour varies from amethystine to nearly colourless or white. The optic axial plane and obtuse bisectrix are perpendicular to $b(010)$. Formula $H_2ZnCaSiO_5$, or, as the water is only expelled at a high temperature, $(ZnOH)(CaOH)SiO_3$.

This is analogous to the hemimorphite formula $H_2Zn_2SiO_5$, or $(ZnOH)_2SiO_3$. [The name clinohedrite is preoccupied.] L. J. S.

Melanotekite from New Mexico. (C. H. Warren, *Amer. Journ. Sci.* 1898, VI. 116).—This mineral, previously only known from Sweden, has recently been found at Hillsboro in New Mexico. It has a dark brown to almost black colour, and gives an ochre-yellow streak resembling that of limonite. Cavities are lined with minute orthorhombic crystals of prismatic habit; $a : b : c = 0{\cdot}6338 : 1 : 0{\cdot}9126$. Analyses give the formula $2Fe_2O_3.3PbO.3SiO_2$. Sp. gr. = 5·854. The formula previously given for melanotekite is $Fe_2O_3.2PbO.2SiO_2$, and for the isomorphous kentrolite, $Mn_2O_3.2PbO.2SiO_2$. The four earlier analyses of these two new minerals show considerable variations, and three of them agree better with the new formula than with the old. L. J. S.

Quartz-alunite Rock. (H. W. Turner, *Amer. Journ. Sci.* 1898, V. 424).—Three sharp buttes, called Tres Cerritos, in Mariposa Co., California, are composed of augite-porphyrite-tuffs and clay-slate which have been subjected to solfataric action. Most of the altered rocks are light brown, and resemble quartzite in appearance. Under the microscope they are seen to consist of quartz and a mineral which was shown by analysis, made on material separated by a heavy liquid, to be alunite, $(K,Na)_2O.3Al_2O_3.4SO_3.6H_2O$. L. J. S.

Phenakite from Kragerö, Norway. (H. Bäckström, *Geol. För. Förh.* 1898, XX. 295-303; and *Zeits. Kryst. Min.* 1898, XXX. 352-356).—Large crystals of phenakite have recently been found in a felspar quarry near Kragerö. They were at first taken to be "rock crystal." They are colourless to grey, and usually clouded, and are sometimes several decimeters in length. The habit is prismatic, and the terminal faces only very rarely show the tetartohedral development so characteristic of phenakite, the apparent symmetry being as a rule that of calcite. The common forms are $a\{10\bar{1}\}$, $r\{100\}$ and $s\{20\bar{1}\}$, also $d\{110\}$, $p\{210\}$, $m\{11\bar{1}\}$, $z\{\bar{1}22\}$, &c., but the common phenakite form $x\{21\bar{1}\}$ is very rare.

C. H. Warren (*Amer. Journ. Sci.* 1898, VI. 119) has described still larger crystals, measuring up to 12 inches in diameter and weighing 28 lbs., from Greenwood, Maine. These are, however, only pseudomorphs of quartz after phenakite.

Phenakite has also been recently recorded from the granite of Striegau in Silesia (C. Hintze, *Zeits. Kryst. Min.* 1897, XXVIII. 174). L. J. S.

Cohenite in telluric Irons from Greenland. (E. Cohen, *Meddelelser om Grönland*, 1897, XV. 293-304).—A carbide of iron, present to the extent of 52 per cent. in the nickel-iron of Niakornak near Jakobshavn in N. Greenland, consists of greyish-black crystalline aggregates with good cleavage. Sp. gr. = 7·5124; analysis gives the formula Fe_3C with the iron partly replaced by nickel and cobalt. Shepard's chalypite, Fe_2C, from the same iron is probably identical with this. An analysis is also given (*Ann. k.k. naturhist. Hofmus.* 1897, XII. 58) of a similar carbide of iron from the well-known Ovifak iron of Disko Island. Both of these are no doubt identical with the meteoric cohenite. L. J. S.

Crystalline Structure of Gold Nuggets. (A. Liversidge, *Journ. Roy. Soc. N. S. Wales*, 1897, XXXI. 70-79; and *Trans. Chem. Soc.* 1897, LXXI. 1125-1131).—In a previous paper (Abstr. XI. 101) the author held the view that gold nuggets have been derived from gold reefs, rather than that they have been deposited *in situ* from solution. In the latter case the structure of the nuggets would be concentric. With the view of testing this, polished sections of gold nuggets have been etched, but no trace of concentric structure was observed. The 16 fine plates illustrating the paper show that the structure of nuggets and ingots of gold platinum and tin is that of an irregular aggregate of interlocking crystals, often of considerable size. L. J. S.

Bornite from the Tyrol. (E. Weinschenk, *Zeits. Kryst. Min.* 1896, XXVI. 392; A. Heimerl, *Tsch. Min. Mitth.* 1897, XVII. 289; C. Klein, *Sitz.-ber. Akad. Berlin*, 1898, 385, 521).—Large isolated crystals of bornite have recently been found in a gold vein on Frossnitz-Alpe in the Gross-Venediger, associated with calcite, albite, gold, chlorite and limonite. They are distorted icositetrahedra with rough, striated faces, and a thin coating of malachite. The forms are {211}, {322}, {533} and {100}. The largest [now in the British Museum] measures $5·6 \times 4·2 \times 4·2$ cm. along the cubic axes. L. J. S.

The so-called anomalous etched figures on monoclinic crystals, especially on Colemanite. (H. Baumhauer, *Zeits. Kryst. Min.* 1898, XXX. 97-117).—After a discussion of his own and other work on the results of etching crystals of diopside, the author describes the figures produced on the cleavage face (010) of colemanite by etching with very dilute acids. Hydrochloric acid was chiefly employed, but similar results were given by sulphuric acid. Three kinds of figures were observed:—

(α) flat; symmetry monoclinic holohedral.

(β) deeper, varying with the strength of the solvent, but no simple relation found; symmetry also monoclinic holohedral.

(γ) which seem to be developed from the (β) figures; *asymmetric*.

The figures (γ) on the faces (010) and ($0\bar{1}0$) are complementary, *i.e.* one set is the reflection of the other. Also a plane through the edges $(110):(1\bar{1}0)$ and $(\bar{1}10):(\bar{1}\bar{1}0)$ divides the crystal into two parts which are symmetrical with respect to (010). There are on (010) two sets I. and II., and on ($0\bar{1}0$) another pair III. and IV., of which I. and IV., II. and III. are parallel, while I. and III., II. and IV. are symmetrical with respect to (010). To determine the structure several plates parallel to (010) were sliced out of the same crystal. Similar results were obtained on all the plates, and it was always found that whenever two plates had been together in the crystal, the figures on the sides, which had formerly been in contact, were identical point for point. Sometimes a (γ) figure would correspond to a (β) figure, which led the author to suppose that the (γ) figures are developed from the (β) figures.

The faces of the forms (100), (001), ($\bar{2}01$) and (110) were also etched. The resulting figures gave monoclinic holohedral symmetry, except some on (100) and (001); but the observations were not sufficiently numerous to determine if the symmetry was the same as in the case of (010).

Since neither careful goniometric measurements of crystals (afterwards etched) nor optical observations reveal any anomalies, and also since holohedral figures accompany the (γ) figures, the author concludes that the symmetry of the crystal is monoclinic and holohedral, but that of the molecule asymmetric. G. F. H. S.

Modifications of Granitic Magma in contact with Limestone. (A. Lacroix, *Comptes rendus*, 1896, CXXIII, 1021-1023).—At the peak of Braceil, in Orlu, Ariège, the granite of Quérigut is in contact with a thick sedimentary series, consisting of schists with thick limestone bands. The schist and limestone have been largely absorbed by the granitic magma, and fragments of these rocks are enclosed in the granite. The granite in contact with the extensively corroded limestone has undergone considerable alterations; by loss of quartz and felspar and development of hornblende and mica, and lastly olivine, it becomes progressively more basic and passes to hornblende granite, quartz diorite, mica diorite, hornblendite, and finally to hornblende peridotite; this being an almost complete series of granular eruptive rocks. Sometimes enstatite is developed, and norites, with or without olivine, result. The plagio-

clases, oligoclase to anorthite, are zoned and much corroded, indicating great variations in the composition of the magma. The green or brown hornblende occurs in large individuals, and, in the more basic rocks, encloses the other minerals. L. J. S.

The Influence of the temperature of dehydration on the 'weathering figures' of Gypsum. [L. Sohncke, *Zeits. Kryst. Min.*, XXX, 1, 1898]. The author states that, in common with other later observers (*Blasius, Zeits. Kryst.*, X, 236, 1885, and Weiss, *Zeits. d. d. geol. Ges.*, XXIX, 211, 1877, and *Zeits. Kryst.*, III, 97) he has been unable to obtain the elliptical 'weathering figures' (*Verwitterungsflecke*) which were found by Pape (*Pogg. Ann.*, CXXXV, 6, 1868) to be produced on the faces of a crystal of gypsum, heated to near 100° C in an air bath, and which corresponded in the position of their axes to an "ellipsoid of weathering." The figures obtained by the author on cleavage surfaces agree with those described by Weiss (*loc. cit.*), and have in general a rectangular outline, whose sides are roughly parallel and perpendicular to the vertical axis. They are traversed by two straight lines nearly coinciding with the diagonals of the rectangle. The upper and lower of the four sectors into which the figure is thus divided show striæ nearly parallel to the vertical axis, while the other two sectors show in addition a striation parallel to the fibrous fracture.

The author has investigated the effect of the temperature used on the form of the figures, and finds that with increase of temperature the ratio of the horizontal to the vertical diameter diminishes.[1]

The direction of the vertical striae makes an angle of some 3° with the vertical axis in the acute angle of the axes (β). The angle between the diagonals is about 81°, their bisectrix lying in the acute angle β, and making $4\frac{1}{2}$° with the vertical. One of the diagonals appears to correspond with the mean axis of thermal expansion. H. L. B.

---

[1] Further, while at low temperatures (105°), the vertical sides of the figure show an outward curvature, the horizontal edges being straight, at higher temperatures the vertical edges are straight while the horizontal ones are rounded or even bent, giving the figure the appearance of a hexagon, and the outline of the figures alters somewhat.

CONTENTS OF No. 55.

PAGE

Plagionite, Heteromorphite and Semseyite as Members of a Natural Group of Minerals. By L. J. Spencer, M.A., F.G.S.; with Analyses by G. T. Prior, M.A., F.G.S., Assistants in the Mineral Department of the British Museum 55

Petrographical Notes on the Rock-specimens collected in Antarctic Regions during the voyage of H.M.S. *Erebus* and *Terror* under Sir James Clark Ross, in 1839-43. By G. T. Prior, M.A., F.G.S., Assistant in the Mineral Department of the British Museum 69

Riebeckite in Trachytic Rocks from Abyssinia. By G. T. Prior, M.A., F.G.S., Assistant in the Mineral Department of the British Museum 92

Minerals from Swaziland: Niobates and titanates of the rare earths, chemically allied to Euxenite and Fergusonite; Cassiterite, Monazite, &c. The "Æschynite" from Hitterö. By G. T. Prior, M.A., F.G.S., Assistant in the Mineral Department of the British Museum 96

On some lead minerals from Laurium, namely, Laurionite, Phosgenite, Fiedlerite, and (new species) Paralaurionite. By G. F. Herbert Smith, B.A.; with Chemical Analysis by G. T. Prior, M.A., F.G.S., Assistants in the Mineral Department of the British Museum 102

Communications from the Oxford Mineralogical Laboratory. I. Mineralogical Notes: Zinc-Blende; Galena; Pyrites; Lead. By Prof. H. A. Miers, M.A., F.R.S.; with Analyses by E. G. J. Hartley, B.A. 111

Note on the Crystals of Lead described in the preceding communication. By Allan Dick 118

II. On the constitution of the mineral Arsenates and Phosphates. By E. G. J. Hartley, B.A. 120

Reviews 123

Obituary. Andreas Arzruni 129

Abstracts 130

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